

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 11-025292

(43)Date of publication of application : 29.01.1999

(51)Int.Cl.

G06T 17/20

(21)Application number : 09-176692

(71)Applicant : HITACHI ENG CO LTD

(22)Date of filing : 02.07.1997

(72)Inventor : NAKAO TAKASHI

NOGUCHI MASAYUKI

TSUKAHARA KAZUNORI

SUZUKI ATSUSHI

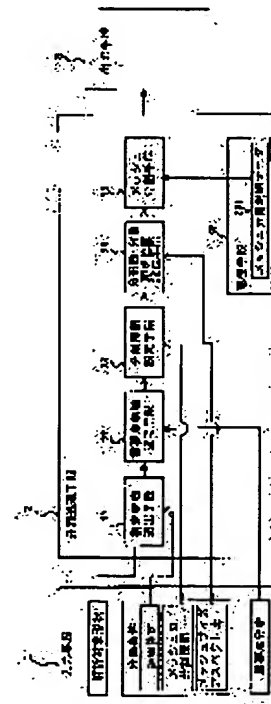
HAMAGUCHI YUKIO

(54) MESH DIVIDING DEVICE AND METHOD THEREFOR

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a mesh dividing device and method for generating a mesh with a size to fulfill required analysis precision, and for automatically dividing each area with a shape to be analyzed in accordance with a desired type of mesh division.

SOLUTION: An inputting means 1 inputs a shape to be analyzed which is preliminarily divided into plural areas with significance distribution and a division condition set for the shape to be analyzed. Based on the significance distribution, a division processing means 2 sets the significance of a mesh division designated area in a mesh division designated area set as per the division condition, and also sets a mesh division type, and the number of divisions and division node position of each side, and mesh-divides the mesh division designated area based on mesh division rule data 261 in which a correlation rule between the number of divisions and division node position and the mesh division type is preliminarily stored.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

Copyright (C); 1998,2003 Japan Patent Office

CLAIMS

[Claim(s)]

[Claim 1] An input means to make the significance distribution and the division conditions which were set as this configuration for analysis accompany the configuration for analysis beforehand divided into two or more fields, and to input, In the mesh division equipment which has the division processing means which carries out mesh division processing of said configuration for analysis based on said significance distribution and said division conditions, and an output means to display said said configuration for analysis by which mesh division was carried out An appointed field election means by which said division processing means elects the mesh division appointed field from said two or more fields based on the conditions of the block definition in said inputted division conditions, A significance field setting-out means to collate said inputted significance distribution and said elected mesh division appointed field, and to set up the significance of said mesh division appointed field, A division class setting-out means to set a mesh division class as the mesh division appointed field to which said significance was set up based on the conditions of the mesh division class in said inputted division conditions, The number of partitions and a division joint positioning means to set up the number of partitions and the division joint location of each side of the mesh division appointed field where said mesh division class was set up, Mesh division equipment characterized by having the mesh division means which carries out mesh division of the mesh division appointed field where said number of partitions and a division joint location were set up based on the mesh division regulation data with which the correlation regulation of the number of partitions, and a division joint location and a mesh division class is stored beforehand.

[Claim 2] It is mesh division equipment characterized by said division class setting-out means setting up at least one kind in equal mesh division, unequal mesh division, and junction mesh division in claim 1 based on said mesh division kind of conditions.

[Claim 3] The input step which the significance distribution and the division conditions which were set as this configuration for analysis are made to accompany the configuration for analysis beforehand divided into two or more fields, and is inputted, In the mesh division approach of having the division processing step which carries out mesh division processing of said configuration for analysis based on said significance distribution and said division conditions, and the output step which displays said said configuration for analysis by which mesh division was carried out The appointed field election step as which said division processing step elects the mesh division appointed field from said two or more fields based on the conditions of the block definition in said inputted division conditions, The significance field setting-out step which collates said inputted significance distribution and said elected mesh division appointed field, and sets up the significance of said mesh division appointed field, The division class setting-out step which sets a mesh division class as the mesh division appointed field to which said significance was set up based on the conditions of the mesh division class in said inputted division conditions, Based on the mesh size in said inputted division conditions, and the conditions of an aspect ratio, in the sequence based on said set-up significance The number of partitions and the division joint positioning step which sets up the number of partitions and the division joint location of each side of the mesh division appointed field where said mesh division class was set up, It is based on the mesh division regulation data with which the correlation regulation of the number of partitions, and a division joint location and a mesh division class is stored beforehand. The mesh division approach characterized by having the mesh division step which carries out mesh division of the mesh division appointed field where said number of partitions and a division joint location were set up.

[Claim 4] It is the mesh division approach characterized by said division class setting-out step setting up at least one kind in equal mesh division, unequal mesh division, and junction mesh division in claim 3 based on said mesh division kind of conditions.

[Claim 5] It is the record medium which recorded the processing program which carries out mesh division processing of the configuration for analysis beforehand divided into two or more fields based

on the significance distribution and the division conditions which were set as this configuration for analysis and in which computer reading is possible. Said processing program makes the mesh division appointed field elect it as a computer from said two or more fields based on the conditions of the block definition in said division conditions. Make said significance distribution and said elected mesh division appointed field collate, and the significance of said mesh division appointed field is made to set up. A mesh division class is made to set it as the mesh division appointed field to which sequence was set up with said significance based on the conditions of the mesh division class in said division conditions. It is based on the mesh size in said division conditions, and the conditions of an aspect ratio. And in order of the ranking of said set-up significance The number of partitions and the division joint location of each side of the mesh division appointed field where said mesh division class was set up are made to set up. The mesh division processing program characterized by carrying out mesh division of the mesh division appointed field where said number of partitions and a division joint location were set up based on the mesh division regulation data with which the correlation regulation of the number of partitions, and a division joint location and a mesh division class is stored beforehand The recorded record medium in which computer reading is possible.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the mesh division equipment and the division approach of carrying out mesh division of the configuration of an analysis object, when performing various analyses of an analysis object with the application of the finite element method.

[0002]

[Description of the Prior Art] Although precision improved when analyzing using the finite element method, and precision generally fell when making a mesh, i.e., an element, coarse, and making the element fine at reverse, the storage capacity and analysis time amount in analysis count increased, and there was a problem that count cost started.

[0003] Therefore, when handicraft creates [an analyst] a mesh, the field where high degree of accuracy is demanded makes [many / small and] an element, attachment of condensation and rarefaction of the element that the field as which low precision is sufficient makes an element greatly and few is performed, and the above and solution of a trouble are in drawing.

[0004] As a system [element] of attachment of condensation and rarefaction, the analysis configuration which configuration significance was made to accompany is inputted, field significance is set as each field of an analysis configuration, and division of condensation and rarefaction is performed according to the of-condensation-and-rarefaction division regulation, for example as indicated by JP,9-6994,A.

[0005]

[Problem(s) to be Solved by the Invention] When an analyst creates a mesh manually and performs attachment of condensation and rarefaction of an element efficiently, equal segmentation of the field where high degree of accuracy is demanded is carried out to a small element, and unequal division of the field as which low precision is sufficient is carried out at a big element. Furthermore, in order to change the number of partitions in the opposite sides of a square field between the field where high degree of accuracy is demanded, and a field good in low precision in the case of a two-dimensional configuration or a three-dimension shell configuration, and in order to change the number of partitions by the confrontations of a hexahedron field in the case of a three-dimension solid configuration, the mesh called a junction is used. Moreover, as it changes over the whole analysis configuration about mesh-size change, he is trying to secure an overall analysis precision.

[0006] However, in order to use for a system the above and given in JP,9-6994,A the discrete value to which field significance was set in a way called 1, 2, and 3, implementation of mesh-size change which was in agreement with the analysis precision demanded was difficult for it, and it had the problem that it was difficult to generate an equal mesh, unequal mesh, and junction mesh to a desired field.

[0007] The object of this invention is to offer the mesh division equipment and the division approach of generating the mesh of the mesh size which fulfills the analysis precision demanded about the mesh generation of the configuration for analysis at the time of performing analysis using the finite element method, and carrying out automatic [of each field of the configuration for analysis] in the mesh of a desired division class.

[0008]

[Means for Solving the Problem] An input means for this invention to make the significance distribution and the division conditions which were set as this configuration for analysis accompany the configuration for analysis beforehand divided into two or more fields, and to input it into it in order to attain the above-mentioned object, In the mesh division equipment which has the division processing means which carries out mesh division processing of said configuration for analysis based on said significance distribution and said division conditions, and an output means to display said said configuration for analysis by which mesh division was carried out An appointed field election means by which said division processing means elects the mesh division appointed field from said two or more

fields based on the conditions of the block definition in said inputted division conditions, A significance field setting-out means to collate said inputted significance distribution and said elected mesh division appointed field, and to set up the significance of said mesh division appointed field, A division class setting-out means to set a mesh division class as the mesh division appointed field to which said significance was set up based on the conditions of the mesh division class in said inputted division conditions, The number of partitions and a division joint positioning means to set up the number of partitions and the division joint location of each side of the mesh division appointed field where said mesh division class was set up, It is characterized by having the mesh division means which carries out mesh division of the mesh division appointed field where said number of partitions and a division joint location were set up based on the mesh division regulation data with which the correlation regulation of the number of partitions, and a division joint location and a mesh division class is stored beforehand. [0009] Moreover, said division class setting-out means is as other descriptions of this invention based on said mesh division kind of conditions to set up at least one kind in equal mesh division, unequal mesh division, and junction mesh division.

[0010] Moreover, the input step which other descriptions of this invention make the significance distribution and the division conditions which were set as this configuration for analysis accompany the configuration for analysis beforehand divided into two or more fields, and is inputted, In the mesh division approach of having the division processing step which carries out mesh division processing of said configuration for analysis based on said significance distribution and said division conditions, and the output step which displays said said configuration for analysis by which mesh division was carried out The appointed field election step as which said division processing step elects the mesh division appointed field from said two or more fields based on the conditions of the block definition in said inputted division conditions, The significance field setting-out step which collates said inputted significance distribution and said elected mesh division appointed field, and sets up the significance of said mesh division appointed field, The division class setting-out step which sets a mesh division class as the mesh division appointed field to which said significance was set up based on the conditions of the mesh division class in said inputted division conditions, Based on the mesh size in said inputted division conditions, and the conditions of an aspect ratio, in the sequence based on said set-up significance The number of partitions and the division joint positioning step which sets up the number of partitions and the division joint location of each side of the mesh division appointed field where said mesh division class was set up, It is in having the mesh division step which carries out mesh division of the mesh division appointed field where said number of partitions and a division joint location were set up based on the mesh division regulation data with which the correlation regulation of the number of partitions, and a division joint location and a mesh division class is stored beforehand.

[0011] According to this invention, the appointed field election means elects the mesh division appointed field from said two or more fields based on the conditions of the block definition in the division conditions inputted from the input means. A significance field setting-out means collates the inputted significance distribution and the elected mesh division appointed field, and sets up the significance of the mesh division appointed field. A division class setting-out means sets a mesh division class as the mesh division appointed field to which said significance was set up based on the conditions of the mesh division class in the inputted division conditions. The number of partitions and a division joint positioning means set up the number of partitions and the division joint location of each side of the mesh division appointed field where the mesh division class was set up. A mesh division means carries out mesh division of the mesh division appointed field where the number of partitions and a division joint location were set up based on the mesh division regulation data with which the correlation regulation of the number of partitions, and a division joint location and a mesh division class is stored beforehand.

[0012] Moreover, a division class setting-out means sets up at least one kind in equal mesh division, unequal mesh division, and junction mesh division based on the conditions of a mesh division class.

[0013] The mesh of the request which could generate the mesh of the mesh size which fulfills the analysis precision demanded to the mesh division appointed field of the configuration for analysis, and

combined equal segmentation, unequal division, and junction division with it for each field of the configuration for analysis by this can be generated automatically.

[0014]

[Embodiment of the Invention] Hereafter, the mesh division equipment and the division approach concerning one example of this invention are explained using a drawing.

[0015] Drawing 1 shows the functional configuration of the mesh division equipment concerning one example of this invention. The input means 1 make the division conditions for dividing the significance distribution and the configuration for analysis which were set as this configuration for analysis accompany the configuration for analysis beforehand divided into two or more fields, and input, the division processing means 2 carry out mesh division processing in the configuration for analysis based on significance distribution and division conditions, and the output means 3 display the configuration for analysis by which mesh division was carried out are consisted of by mesh division equipment.

[0016] The input means 1 is a means for inputting the division conditions for dividing the field of the configuration for analysis by which field division was carried out, and the significance distribution beforehand set up to the configuration for analysis and the configuration for analysis.

[0017] Significance distribution shows a degree to analyze with a sufficient precision of the field divided in the configuration for analysis, a field to analyze with the most sufficient precision is expressed as a field where significance is the highest, and significance becomes low one by one hereafter according to a precision demand.

[0018] Moreover, division conditions point out the mesh size which shows directions of the field which performs mesh division in the configuration for analysis by which field division was carried out, the division class (equal segmentation, unequal division, and junction division) of mesh, and mesh area, the aspect ratio which shows the ratio of the die length of a mesh in every direction.

[0019] An analyst, i.e., an operator, can input the configuration for analysis by which field division was carried out, the significance distribution set up beforehand, and division conditions with a keyboard, a mouse, etc.

[0020] Moreover, the configuration for analysis by which field division was carried out, significance distribution, and division conditions are beforehand stored in the data file, and a data file may be inputted with the input means 1.

[0021] An appointed field election means 21 to elect two or more mesh division appointed fields from the fields of the configuration for analysis by which field division was carried out based on the conditions of the block definition in the division conditions as which the division processing means 2 was inputted from the input means 1, A significance field setting-out means 22 to collate the significance distribution inputted from the input means 1, and each elected mesh division appointed field, and to set up the significance of each mesh division appointed field, A division class setting-out means 23 to set a mesh division class as each mesh division appointed field to which significance was set up based on the conditions of the mesh division class in the division conditions inputted from the input means 1, It is based on the mesh size in the division conditions inputted from the input means 1, and the conditions of an aspect ratio. The number of partitions and a division joint positioning means 24 to set up the number of partitions and the division joint location of each side of each mesh division appointed field where the mesh division class was set up, It is based on the mesh division regulation data 261 with which the correlation regulation of the number of partitions, and a division joint location and a mesh division class is stored beforehand. It consists of a mesh division means 25 which carries out mesh division of each mesh division appointed field where the number of partitions and a division joint location were set up, and a storage means 26 by which the mesh division regulation data 261, data required for various kinds of processings, etc. are stored.

[0022] Moreover, the division processing means 2, the appointed field election means 21, the significance field setting-out means 22, the division class setting-out means 23, the number of partitions and a division joint positioning means 24, the mesh division means 25, and the storage means 26 can be performed with electron devices, such as CPU, ROM (the program which performs predetermined processing beforehand is built in), RAM, and various kinds CMOS.

[0023] When a series of processings are completed, the output means 3 is a means to output the division condition of the configuration for analysis by which mesh division was carried out, for example, printing means, such as display means, such as CRT, an EL display, and a liquid crystal display, and a laser beam printer, a dot impact printer, an X-Y plotter, can realize it.

[0024] Drawing 2 shows the flow chart of the mesh division processing concerning one example of this invention. In introduction and step 100, input process of the configuration for analysis by which field division was carried out, the significance distribution beforehand set as this configuration for analysis, and division conditions is performed.

[0025] Next, the mesh configuration of each field of the configuration for analysis is generated by the division processing means 2. That is, based on the significance distribution and the division conditions which were beforehand set as the configuration for analysis and this configuration for analysis by which field division was inputted and carried out at step 100, mesh division of the field is carried out according to the regulation suitable for the usage condition from two or more mesh division regulations beforehand stored as mesh division regulation data 261 in the storage means 26 (110).

[0026] Next, the mesh of the configuration for analysis by which mesh division was carried out is outputted with the output means 3 (120).

[0027] Drawing 3 shows the detailed flow chart of division processing of step 110 of drawing 2. In introduction and step 200, two or more mesh division appointed fields are elected from the fields of the configuration for analysis by which field division was carried out based on the conditions of the block definition in the inputted division conditions. Next, the significance distribution inputted as each elected mesh division appointed field is collated, and the significance of each mesh division appointed field is set up (210). Next, based on the conditions of the mesh division class in the inputted division conditions, a mesh division class is set as each mesh division appointed field to which significance was set up (220). Next, based on the mesh size in the inputted division conditions, and the conditions of an aspect ratio, the number of partitions and the division joint location of each side of each mesh division appointed field where the mesh division class was set up are set up in the sequence based on the set-up significance (230). Next, based on the mesh division regulation data with which the correlation regulation of the number of partitions, and a division joint location and a mesh division class is stored beforehand, mesh division of each mesh division appointed field where the number of partitions and a division joint location were set up is carried out (240).

[0028] Drawing 4, drawing 5, and drawing 7 are flow charts which show concrete processing by the mesh division class set up at step 220 of drawing 3. Operation of step 110 of drawing 2 can also be used here combining plurality, using only one of drawing 4, drawing 5, and drawing 7.

[0029] Drawing 4 is equal or a flow chart which shows unequal mesh division processing. The field where significance is the highest is set up as an object domain among introduction and the appointed field group (step 300). Next, it judges whether mesh division of all the appointed field groups was carried out (310), and if mesh division of all the appointed field groups is made, it will end.

[0030] equal in an object domain, if mesh division of all the appointed field groups is not completed at step 310 -- or unequal mesh division is carried out (320) and the number of partitions and the division joint location of the same direction are set up to the appointed field group which is not divided [of the direction of an object domain in every direction] (330).

[0031] Next, if judge (340) and it is [whether there is any field where only the number of partitions and the division joint location of an one direction in every direction are set up, and] among the appointed field groups, the field where significance is the highest will be set up as an object domain among those fields (350), and it will return to step 310. If there is no field to which only the number of partitions and the division joint location of an one direction in every direction are set among the appointed field groups at step 340, the field where significance is the highest will be set up as an object domain among the non-divided appointed field groups (360), and it will return to step 310.

[0032] Drawing 5 is a flow chart which shows junction mesh division processing. The field where significance is the highest is set up as an object domain among introduction and the appointed field group (step 400), and it judges whether mesh division of all the appointed field groups was carried out

(410), and if mesh division of all the appointed field groups is carried out, it will end.

[0033] If mesh division of all the appointed field groups is not completed at step 410, junction mesh division of the object domain is carried out (420), the field where significance is the highest is set up as an object domain among the non-divided appointed field groups (430), and it returns to step 410.

[0034] Drawing 6 is a detailed flow chart which shows the processing which carries out junction mesh division of the object domain of step 420 of drawing 5. Based on the number of partitions and the division joint location of introduction, division conditions, significance, and an adjoining field, the number of partitions and the division joint location of each side of an object domain are determined (step 500). Next, the subregion where the object domain was divided by the number of partitions which determined the subdirection (510), and the principal direction main division side was divided is set up as object subregion (520).

[0035] A subdirection and principal direction main division side is explained to a detail later.

[0036] Next, it judges whether mesh division of the part field was all carried out (530), and if mesh division of the part field is all carried out, it will end. If mesh division of a part field all is not completed at step 530, junction mesh division of the object subregion is carried out (540), the subregion whose next door of object subregion is not divided is set up as object subregion (550), and it returns to step 530.

[0037] Drawing 7 is equality, a junction, and a detailed flow chart that shows the compound mesh division processing which performs unequal mesh division one by one. Introduction and the field group which performs equal mesh division are set up as an appointed field group (step 600), and equal mesh division of the appointed field group is carried out using the processing explained by drawing 4 (610).

[0038] Next, the field group which performs junction mesh division is set up as an appointed field group (620), and junction mesh division of the appointed field group is carried out using the processing explained by drawing 5 (630). Next, the field group of all the remainder that perform unequal mesh division is set as the appointed field group (640), and unequal mesh division of the appointed field group is carried out using the processing explained by drawing 4 (650).

[0039] Next, significance distribution, the main-sub direction of a field, and main-sub division are explained using drawing 13 and drawing 14.

[0040] Drawing 13 is drawing showing the example of significance distribution when maximum of significance is set to 1.0 and it sets the minimum value to 0. It is an example for which significance decreases as distance separates significance distribution of this example from the part where significance is the highest.

[0041] Drawing 14 shows one field which consists of the side 1200, the side 1210, the side 1220, and the side 1230, and significance [in / in significance / in / in significance / in / in the significance in the side 1200 / 0.6 and the side 1210 / 0.4 and the side 1220 / 0.5 and the side 1230] shows the example of 0.8.

[0042] A principal direction points out the direction of [with the larger difference of the significance of the opposite sides], and the side 1210 serves as a principal direction from the side 1230. The subdirection points out the direction of [with the smaller difference of the significance of the opposite sides], and the side 1220 serves as the subdirection from the side 1200.

[0043] The main division side points out the side where the significance of the opposite sides is high, in the case of the side 1230 and the side 1210, the side 1230 becomes the main division side and the side 1210 becomes with a subdivision side. In the case of the side 1200 and the side 1220, the side 1200 becomes the main division side and the side 1220 becomes with a subdivision side.

[0044] Next, the example of an equal mesh division regulation, an unequal mesh division regulation, and a junction mesh division regulation is explained using drawing 12. As shown in (a), when the number of partitions of the opposite side of a field 1100 is equal, an equal mesh division regulation is a regulation which determines a division joint location and carries out mesh division, as each side is divided into equal die length by the number of partitions, and serves as the division configuration 1110 after division.

[0045] It is the regulation which determines a division joint location and carries out mesh division so that a mesh may become large at **** the side low from the side high [of significance] when the

number of partitions of the opposite side of a field 1120 is equal and each side may be divided into die length unequal at the number of partitions, as an unequal mesh division regulation is shown in (b), and becomes the division-after division configuration 1130.

[0046] As shown in (c) and (d), when the numbers of partitions of the opposite side of a field 1140 or a field 1160 differ, a junction mesh division regulation is a regulation which determines a division joint location and carries out mesh division, as a field consists of two or more squares, and serves as the division configuration 1150 and the division configuration 1170 after division.

[0047] Although the mesh division regulation shown here remains for having indicated an example, actually, it can consider many mesh division regulations and is memorized by the storage means 26 as mesh division regulation data 261.

[0048] Next, based on the flow chart of drawing 4, the example of equal mesh division of operation is concretely explained using drawing 8 R> 8. Drawing 8 (a) is beforehand divided into two or more fields, and shows the configuration 700 for analysis where Field a, Field b, Field c, and Field d were specified as an appointed field group. Drawing 8 (b) is the significance distribution map 710 in which P upper left corners of the configuration 700 for analysis showed significance distribution when significance is set up highly with the contour line most.

[0049] First, at step 300, the field a where significance is the highest is set up as an object domain among the appointed field groups. Next, since mesh division of all the appointed field groups has not been carried out (310), it progresses to step 320. At step 320, as an object domain a is shown in the configuration 720 for analysis of drawing 8 (c) based on conditions, such as significance distribution, a mesh size, and an aspect ratio, equal mesh division is performed.

[0050] At step 330, the number of partitions and the division joint location of the same direction are set up to the appointed field group (Field b, Field c) which is not divided [of the direction of an object domain a in every direction]. The figure described into the field b of the configuration 720 for analysis and Field c is the number of partitions of said same direction. Moreover, the division joint location according to the number of partitions is set up on the side of a field, and two points [S], Field a and ***** , are division joint locations in Field c.

[0051] Next, by judging whether there is any field to which only the number of partitions and the division joint location of an one direction in every direction are set among the appointed field groups (340), since only the number of partitions and the division joint location of an one direction are set up, as for Field b and Field c, the field c where significance is the highest is set up as an object domain among those fields (350), and it progresses to step 310.

[0052] Since mesh division of all the appointed field groups is not completed at step 310, as an object domain c is shown in the configuration 730 for analysis of drawing 8 (d) based on conditions, such as significance distribution, a mesh size, and an aspect ratio, equal mesh division is performed (320).

[0053] At step 330, the number of partitions and the division joint location of the same direction are set up to the appointed field group (field d) which is not divided [of the direction of an object domain c in every direction].

[0054] Next, by judging whether there is any field to which only the number of partitions and the division joint location of an one direction in every direction are set among the appointed field groups (340), since only the number of partitions and the division joint location of an one direction are set up, as for Field b and Field d, the field b where significance is the highest is set up as an object domain among those fields (350), and it progresses to step 310.

[0055] Since mesh division of all the appointed field groups is not completed at step 310, as an object domain b is shown in the configuration 740 for analysis of drawing 8 (e) based on conditions, such as significance distribution, a mesh size, and an aspect ratio, equal mesh division is performed (320).

[0056] At step 330, since there is no appointed field group which is not divided [of the direction of an object domain b in every direction], it progresses to step 340. It judges whether there is any field to which only the number of partitions and the division joint location of an one direction in every direction are set among the appointed field groups (340), and since, as for Field d, only the number of partitions and the division joint location of an one direction are set up, Field d is set up as an object domain (350),

and progresses to step 310.

[0057] Since mesh division of all the appointed field groups is not completed at step 310, as an object domain d is shown in the configuration 750 for analysis of drawing 8 (f) based on conditions, such as significance distribution, a mesh size, and an aspect ratio, equal mesh division is performed (320).

[0058] At step 330, since there is no appointed field group which is not divided [of the direction of an object domain d in every direction], it progresses to step 340. It judges whether there is any field to which only the number of partitions and the division joint location of an one direction in every direction are set among the appointed field groups (340), is judged with no, and progresses to step 360.

[0059] At step 360, since there is no non-divided appointed field group, an object domain becomes undecided and it progresses to step 310. Since mesh division of all the appointed field groups is carried out at step 310, it is ended.

[0060] Next, based on the flow chart of drawing 4, the example of unequal mesh division of operation is concretely explained using drawing 9 R> 9. Drawing 9 (a) is beforehand divided into two or more fields, and shows the configuration 800 for analysis where Field a, Field b, Field c, and Field d were specified as an appointed field group. Drawing 9 (b) is the significance distribution map 810 in which P upper left corners of the configuration 800 for analysis showed significance distribution when significance is set up highly with the contour line most.

[0061] First, at step 300, the field a where significance is the highest is set up as an object domain among the appointed field groups. Next, since mesh division of all the appointed field groups has not been carried out (310), it progresses to step 320.

[0062] At step 320, as shown in the configuration 820 for analysis of drawing 9 (c), unequal mesh division is performed so that a mesh size may become large from the main division side to a subdivision side about an object domain a at **** by deciding inequality split ratio based on conditions, such as significance distribution, a mesh size, and an aspect ratio.

[0063] At step 330, the number of partitions and the division joint location of the same direction are set up to the appointed field group (Field b, Field c) which is not divided [of the direction of an object domain a in every direction]. The figure described into the field b of 830 and Field c is the number of partitions of said same direction. Moreover, in Field c, five points [S] of Field a and ***** are division joint locations.

[0064] Next, by judging whether there is any field to which only the number of partitions and the division joint location of an one direction in every direction are set among the appointed field groups (340), since only the number of partitions and the division joint location of an one direction are set up, as for Field b and Field c, the field c where significance is the highest is set up as an object domain among those fields (350), and it progresses to step 310.

[0065] Since mesh division of all the appointed field groups is not completed at step 310, as an object domain c is shown in the configuration 830 for analysis of drawing 9 (d) based on conditions, such as significance distribution, a mesh size, and an aspect ratio, unequal mesh division is performed (320).

[0066] At step 330, the number of partitions and the division joint location of the same direction are set up to the appointed field group (field d) which is not divided [of the direction of an object domain c in every direction].

[0067] Next, by judging whether there is any field to which only the number of partitions and the division joint location of an one direction in every direction are set among the appointed field groups (340), since only the number of partitions and the division joint location of an one direction are set up, as for Field b and Field d, the field b where significance is the highest is set up as an object domain among those fields (350), and it progresses to step 310.

[0068] Since mesh division of all the appointed field groups is not completed at step 310, as an object domain b is shown in the configuration 840 for analysis of drawing 9 (e) based on conditions, such as significance distribution, a mesh size, and an aspect ratio, unequal mesh division is performed (320).

[0069] At step 330, since there is no appointed field group which is not divided [of the direction of an object domain b in every direction], it progresses to step 340. It judges whether there is any field to which only the number of partitions and the division joint location of an one direction in every direction

are set among the appointed field groups (340), and since, as for Field d, only the number of partitions and the division joint location of an one direction are set up, Field d is set up as an object domain (350), and progresses to step 310.

[0070] Since mesh division of all the appointed field groups is not completed at step 310, as an object domain d is shown in the configuration 850 for analysis of drawing 9 (f) based on conditions, such as significance distribution, a mesh size, and an aspect ratio, equal mesh division is performed (320).

[0071] At step 330, since there is no appointed field group which is not divided [of the direction of an object domain d in every direction], it progresses to step 340. It judges whether there is any field to which only the number of partitions and the division joint location of an one direction in every direction are set among the appointed field groups (340), is judged with no, and progresses to step 360.

[0072] At step 360, since there is no non-divided appointed field group, an object domain becomes undecided and it progresses to step 310. Since mesh division of all the appointed field groups is carried out at step 310, it is ended.

[0073] Next, based on the flow chart of drawing 5 and drawing 6, the example of junction mesh division of operation is concretely explained using drawing 10. Drawing 10 (a) is beforehand divided into two or more fields, and shows the configuration 900 for analysis where Field a and Field b were specified as an appointed field group. Drawing 10 (b) is the significance distribution map 910 in which P upper left corners of the configuration 900 for analysis showed significance distribution when significance is set up highly with the contour line most.

[0074] The configuration 920 for analysis of drawing 10 (c) shows the number of partitions of the side where it is decided except the appointed field group that the number of partitions of the appointed field group and a division joint location will be the mesh configurations of the field by which mesh division has already been carried out.

[0075] First, at step 400, the field a where significance is the highest is set up as an object domain among the appointed field groups. Next, since mesh division of all the appointed field groups has not been carried out (410), it progresses to step 420.

[0076] At step 420, it progresses to step 500 of drawing 6, and as shown in the configuration 930 for analysis of drawing 10 (d), based on the number of partitions and the division joint location of division conditions, significance distribution, and an adjoining field, the number of partitions and the division joint location of each side of an object domain are determined.

[0077] Next, by dividing by the number of partitions which determined the subdirection at step 510, as shown in the configuration 940 for analysis of drawing 10 (e), an object domain a is divided into subregion a1 and subregion a2.

[0078] Since the subregion a1 where the principal direction main division side was divided is set up as object subregion (520) and mesh division of the part field all has not been carried out (530), as shown in the configuration 950 for analysis of drawing 10 (f), junction mesh division is performed for the object subregion a1 using a mesh division regulation (540).

[0079] The subregion a2 whose next door of the object subregion a1 is not divided is set up as object subregion (550), and it progresses to step 530. Since mesh division of a part field all is not completed (530), as shown in the configuration 960 for analysis of drawing 10 (g), mesh division is performed for the object subregion a2 using a mesh division regulation (540).

[0080] Since object subregion was un-setting up since there was no subregion whose next door of the object subregion a2 is not divided (550), and mesh division of the part field was all carried out (530), it ends and progresses to step 430 of drawing 5.

[0081] At step 430, the field b where significance is the highest is set up as an object domain among the non-divided appointed field groups, and it progresses to step 410. Since mesh division of all the appointed field groups is not ended (410), in order to carry out junction mesh division of the object domain b (420), it progresses to step 500 of drawing 6.

[0082] As shown in the configuration 960 for analysis of drawing 10 (g), as shown in (510) and the configuration 970 for analysis of drawing 10 (h), at step 500, an object domain b is divided into subregion b1 and subregion b2 by dividing by the number of partitions which determined the number of

partitions and the division joint location of each side of an object domain based on the number of partitions and the division joint location of division conditions, significance distribution, and an adjoining field, and determined the subdirection.

[0083] Since the subregion b1 where the principal direction main division side was divided is set up as object subregion (520) and mesh division of the part field all has not been carried out (530), as shown in the configuration 980 for analysis of drawing 10 (i), junction mesh division is performed for the object subregion b1 using a mesh division regulation (540).

[0084] The subregion b2 whose next door of the object subregion b1 is not divided is set up as object subregion (550), and it progresses to step 530. Since mesh division of a part field all is not completed (530), as shown in the configuration 990 for analysis of drawing 10 (j), mesh division is performed for the object subregion b2 using a mesh division regulation (540).

[0085] Since object subregion was un-setting up since there was no subregion whose next door of the object subregion b2 is not divided (550), and mesh division of the part field was all carried out (530), it ends and progresses to step 430 of drawing 5. At step 430, since there is no non-divided appointed field, an object domain is un-setting up, and since mesh division of all the appointed field groups was carried out (410), it ends.

[0086] Next, based on the flow chart of drawing 7, it combines using drawing 1111 and the example of mesh division of operation is explained concretely. Drawing 11 (a) shows the configuration 1000 for analysis beforehand divided into two or more Fields a, Fields b, and Fields c. As for drawing 11 (b), 1010 is the significance distribution map 1010 in which Q left part cores of the configuration 1000 for analysis showed significance distribution when significance is set up highly with the contour line most.

[0087] First, at step 600, Field a is set as the appointed field group as a field group which performs equal mesh division, and equal mesh division is carried out using the processing which showed the appointed field a to drawing 4 as shown in the configuration 1020 for analysis of drawing 1111 (c) (610).

[0088] Next, at step 620, Field b is set as the appointed field group as a field group which performs junction mesh division, and junction mesh division is carried out using the processing which showed the appointed field b to drawing 5 and drawing 6 as shown in the configuration 1030 for analysis of drawing 11 (d) (630).

[0089] At step 640, Field c is set as the appointed field group as a field group which performs unequal mesh division, and as shown in the configuration 1040 for analysis of drawing 11 (e), unequal mesh division of the appointed field c is carried out using the processing shown in drawing 4 (650), and it ends.

[0090] Drawing 15 shows the flow chart of the processing which makes the total number of mesh of the appointed field group after mesh division approach the predetermined number of target mesh.

[0091] The conditions from which the number of the appointed field **** mesh serves as min within the limits of introduction and division conditions are set up (step 1300). Next, based on the conditions and significance distribution which were set up, mesh division of the appointed field group is carried out (1310). Next, if the divided number of the appointed field **** mesh is comparable as the number of target mesh (1320), it will end.

[0092] If the number of the appointed field **** mesh is not comparable as the number of target mesh (1320), it will progress to step 1330. It judges whether there are few appointed field **** mesh than the number of target mesh (1330), in being few, it updates so that the number of the appointed field **** mesh may increase the set-up conditions (1340), and it returns to step 1310.

[0093] If the number of the appointed field **** mesh becomes more than the number of target mesh by the judgment of step 1330, the set-up conditions will be updated so that the number of the appointed field group mesh may decrease (1350), and it will return to step 1310.

[0094] Thus, the total number of mesh of the appointed field group suitable for the analysis precision to need is manageable by carrying out processing made to approach the number of target mesh.

[0095] Although the above example was explained taking the case of division processing of a two-dimensional configuration, it can perform mesh division of a three-dimension solid configuration by transposing a two-dimensional line to a field also in the configuration of a three-dimension solid.

[0096]

[Effect of the Invention] According to this invention, in mesh division of the configuration for analysis, it becomes possible to generate automatically the mesh of the request which could generate the mesh of size change which fulfills the analysis precision demanded, and combined equal segmentation, unequal division, and junction division for each field of the configuration for analysis. Reduction of the storage capacity in analysis count and compaction of analysis time amount, i.e., reduction of count cost, can be aimed at this securing the precision of the part which needs analysis precision.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to the mesh division equipment and the division approach of carrying out mesh division of the configuration of an analysis object, when performing various analyses of an analysis object with the application of the finite element method.

[Translation done.]

PRIOR ART

[Description of the Prior Art] Although precision improved when analyzing using the finite element method, and precision generally fell when making a mesh, i.e., an element, coarse, and making the element fine at reverse, the storage capacity and analysis time amount in analysis count increased, and there was a problem that count cost started.

[0003] Therefore, when handicraft creates [an analyst] a mesh, the field where high degree of accuracy is demanded makes [many / small and] an element, attachment of condensation and rarefaction of the element that the field as which low precision is sufficient makes an element greatly and few is performed, and the above and solution of a trouble are in drawing.

[0004] As a system [element] of attachment of condensation and rarefaction, the analysis configuration which configuration significance was made to accompany is inputted, field significance is set as each field of an analysis configuration, and division of condensation and rarefaction is performed according to the of-condensation-and-rarefaction division regulation, for example as indicated by JP,9-6994,A.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] According to this invention, in mesh division of the configuration for analysis, it becomes possible to generate automatically the mesh of the request which could generate the mesh of size change which fulfills the analysis precision demanded, and combined equal segmentation, unequal division, and junction division for each field of the configuration for analysis. Reduction of the storage capacity in analysis count and compaction of analysis time amount, i.e., reduction of count cost, can be aimed at this securing the precision of the part which needs analysis precision.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] When an analyst creates a mesh manually and performs attachment of condensation and rarefaction of an element efficiently, equal segmentation of the field where high degree of accuracy is demanded is carried out to a small element, and unequal division of the field as which low precision is sufficient is carried out at a big element. Furthermore, in order to change the number of partitions in the opposite sides of a square field between the field where high degree of accuracy is demanded, and a field good in low precision in the case of a two-dimensional configuration or a three-dimension shell configuration, and in order to change the number of partitions by the confrontations of a hexahedron field in the case of a three-dimension solid configuration, the mesh called a junction is used. Moreover, as it changes over the whole analysis configuration about mesh-size change, he is trying to secure an overall analysis precision.

[0006] However, in order to use for a system the above and given in JP,9-6994,A the discrete value to which field significance was set in a way called 1, 2, and 3, implementation of mesh-size change which was in agreement with the analysis precision demanded was difficult for it, and it had the problem that it was difficult to generate an equal mesh, unequal mesh, and junction mesh to a desired field.

[0007] The object of this invention is to offer the mesh division equipment and the division approach of generating the mesh of the mesh size which fulfills the analysis precision demanded about the mesh generation of the configuration for analysis at the time of performing analysis using the finite element method, and carrying out automatic [of each field of the configuration for analysis] in the mesh of a desired division class.

[Translation done.]

MEANS

[Means for Solving the Problem] An input means for this invention to make the significance distribution and the division conditions which were set as this configuration for analysis accompany the configuration for analysis beforehand divided into two or more fields, and to input it into it in order to attain the above-mentioned object, In the mesh division equipment which has the division processing means which carries out mesh division processing of said configuration for analysis based on said significance distribution and said division conditions, and an output means to display said said configuration for analysis by which mesh division was carried out An appointed field election means by which said division processing means elects the mesh division appointed field from said two or more fields based on the conditions of the block definition in said inputted division conditions, A significance field setting-out means to collate said inputted significance distribution and said elected mesh division appointed field, and to set up the significance of said mesh division appointed field, A division class setting-out means to set a mesh division class as the mesh division appointed field to which said significance was set up based on the conditions of the mesh division class in said inputted division conditions, The number of partitions and a division joint positioning means to set up the number of partitions and the division joint location of each side of the mesh division appointed field where said mesh division class was set up, It is characterized by having the mesh division means which carries out mesh division of the mesh division appointed field where said number of partitions and a division joint location were set up based on the mesh division regulation data with which the correlation regulation of the number of partitions, and a division joint location and a mesh division class is stored beforehand. [0009] Moreover, said division class setting-out means is as other descriptions of this invention based on said mesh division kind of conditions to set up at least one kind in equal mesh division, unequal mesh division, and junction mesh division.

[0010] Moreover, the input step which other descriptions of this invention make the significance distribution and the division conditions which were set as this configuration for analysis accompany the configuration for analysis beforehand divided into two or more fields, and is inputted, In the mesh division approach of having the division processing step which carries out mesh division processing of said configuration for analysis based on said significance distribution and said division conditions, and the output step which displays said said configuration for analysis by which mesh division was carried out The appointed field election step as which said division processing step elects the mesh division appointed field from said two or more fields based on the conditions of the block definition in said inputted division conditions, The significance field setting-out step which collates said inputted significance distribution and said elected mesh division appointed field, and sets up the significance of said mesh division appointed field, The division class setting-out step which sets a mesh division class as the mesh division appointed field to which said significance was set up based on the conditions of the mesh division class in said inputted division conditions, Based on the mesh size in said inputted division conditions, and the conditions of an aspect ratio, in the sequence based on said set-up significance The number of partitions and the division joint positioning step which sets up the number of partitions and the division joint location of each side of the mesh division appointed field where said mesh division class was set up, It is in having the mesh division step which carries out mesh division of the mesh division appointed field where said number of partitions and a division joint location were set up based on the mesh division regulation data with which the correlation regulation of the number of partitions, and a division joint location and a mesh division class is stored beforehand.

[0011] According to this invention, the appointed field election means elects the mesh division appointed field from said two or more fields based on the conditions of the block definition in the division conditions inputted from the input means. A significance field setting-out means collates the inputted significance distribution and the elected mesh division appointed field, and sets up the significance of the mesh division appointed field. A division class setting-out means sets a mesh division class as the mesh division appointed field to which said significance was set up based on the

conditions of the mesh division class in the inputted division conditions. The number of partitions and a division joint positioning means set up the number of partitions and the division joint location of each side of the mesh division appointed field where the mesh division class was set up. A mesh division means carries out mesh division of the mesh division appointed field where the number of partitions and a division joint location were set up based on the mesh division regulation data with which the correlation regulation of the number of partitions, and a division joint location and a mesh division class is stored beforehand.

[0012] Moreover, a division class setting-out means sets up at least one kind in equal mesh division, unequal mesh division, and junction mesh division based on the conditions of a mesh division class.

[0013] The mesh of the request which could generate the mesh of the mesh size which fulfills the analysis precision demanded to the mesh division appointed field of the configuration for analysis, and combined equal segmentation, unequal division, and junction division with it for each field of the configuration for analysis by this can be generated automatically.

[0014]

[Embodiment of the Invention] Hereafter, the mesh division equipment and the division approach concerning one example of this invention are explained using a drawing.

[0015] Drawing 1 shows the functional configuration of the mesh division equipment concerning one example of this invention. The input means 1 make the division conditions for dividing the significance distribution and the configuration for analysis which were set as this configuration for analysis accompany the configuration for analysis beforehand divided into two or more fields, and input, the division processing means 2 carry out mesh division processing in the configuration for analysis based on significance distribution and division conditions, and the output means 3 display the configuration for analysis by which mesh division was carried out are consisted of by mesh division equipment.

[0016] The input means 1 is a means for inputting the division conditions for dividing the field of the configuration for analysis by which field division was carried out, and the significance distribution beforehand set up to the configuration for analysis and the configuration for analysis.

[0017] Significance distribution shows a degree to analyze with a sufficient precision of the field divided in the configuration for analysis, a field to analyze with the most sufficient precision is expressed as a field where significance is the highest, and significance becomes low one by one hereafter according to a precision demand.

[0018] Moreover, division conditions point out the mesh size which shows directions of the field which performs mesh division in the configuration for analysis by which field division was carried out, the division class (equal segmentation, unequal division, and junction division) of mesh, and mesh area, the aspect ratio which shows the ratio of the die length of a mesh in every direction.

[0019] An analyst, i.e., an operator, can input the configuration for analysis by which field division was carried out, the significance distribution set up beforehand, and division conditions with a keyboard, a mouse, etc.

[0020] Moreover, the configuration for analysis by which field division was carried out, significance distribution, and division conditions are beforehand stored in the data file, and a data file may be inputted with the input means 1.

[0021] An appointed field election means 21 to elect two or more mesh division appointed fields from the fields of the configuration for analysis by which field division was carried out based on the conditions of the block definition in the division conditions as which the division processing means 2 was inputted from the input means 1, A significance field setting-out means 22 to collate the significance distribution inputted from the input means 1, and each elected mesh division appointed field, and to set up the significance of each mesh division appointed field, A division class setting-out means 23 to set a mesh division class as each mesh division appointed field to which significance was set up based on the conditions of the mesh division class in the division conditions inputted from the input means 1, It is based on the mesh size in the division conditions inputted from the input means 1, and the conditions of an aspect ratio. The number of partitions and a division joint positioning means 24 to set up the number of partitions and the division joint location of each side of each mesh division

appointed field where the mesh division class was set up, It is based on the mesh division regulation data 261 with which the correlation regulation of the number of partitions, and a division joint location and a mesh division class is stored beforehand. It consists of a mesh division means 25 which carries out mesh division of each mesh division appointed field where the number of partitions and a division joint location were set up, and a storage means 26 by which the mesh division regulation data 261, data required for various kinds of processings, etc. are stored.

[0022] Moreover, the division processing means 2, the appointed field election means 21, the significance field setting-out means 22, the division class setting-out means 23, the number of partitions and a division joint positioning means 24, the mesh division means 25, and the storage means 26 can be performed with electron devices, such as CPU, ROM (the program which performs predetermined processing beforehand is built in), RAM, and various kinds CMOS.

[0023] When a series of processings are completed, the output means 3 is a means to output the division condition of the configuration for analysis by which mesh division was carried out, for example, printing means, such as display means, such as CRT, an EL display, and a liquid crystal display, and a laser beam printer, a dot impact printer, an X-Y plotter, can realize it.

[0024] Drawing 2 shows the flow chart of the mesh division processing concerning one example of this invention. In introduction and step 100, input process of the configuration for analysis by which field division was carried out, the significance distribution beforehand set as this configuration for analysis, and division conditions is performed.

[0025] Next, the mesh configuration of each field of the configuration for analysis is generated by the division processing means 2. That is, based on the significance distribution and the division conditions which were beforehand set as the configuration for analysis and this configuration for analysis by which field division was inputted and carried out at step 100, mesh division of the field is carried out according to the regulation suitable for the usage condition from two or more mesh division regulations beforehand stored as mesh division regulation data 261 in the storage means 26 (110).

[0026] Next, the mesh of the configuration for analysis by which mesh division was carried out is outputted with the output means 3 (120).

[0027] Drawing 3 shows the detailed flow chart of division processing of step 110 of drawing 2. In introduction and step 200, two or more mesh division appointed fields are elected from the fields of the configuration for analysis by which field division was carried out based on the conditions of the block definition in the inputted division conditions. Next, the significance distribution inputted as each elected mesh division appointed field is collated, and the significance of each mesh division appointed field is set up (210). Next, based on the conditions of the mesh division class in the inputted division conditions, a mesh division class is set as each mesh division appointed field to which significance was set up (220). Next, based on the mesh size in the inputted division conditions, and the conditions of an aspect ratio, the number of partitions and the division joint location of each side of each mesh division appointed field where the mesh division class was set up are set up in the sequence based on the set-up significance (230). Next, based on the mesh division regulation data with which the correlation regulation of the number of partitions, and a division joint location and a mesh division class is stored beforehand, mesh division of each mesh division appointed field where the number of partitions and a division joint location were set up is carried out (240).

[0028] Drawing 4, drawing 5, and drawing 7 are flow charts which show concrete processing by the mesh division class set up at step 220 of drawing 3. Operation of step 110 of drawing 2 can also be used here combining plurality, using only one of drawing 4, drawing 5, and drawing 7.

[0029] Drawing 4 is equal or a flow chart which shows unequal mesh division processing. The field where significance is the highest is set up as an object domain among introduction and the appointed field group (step 300). Next, it judges whether mesh division of all the appointed field groups was carried out (310), and if mesh division of all the appointed field groups is made, it will end.

[0030] equal in an object domain, if mesh division of all the appointed field groups is not completed at step 310 -- or unequal mesh division is carried out (320) and the number of partitions and the division joint location of the same direction are set up to the appointed field group which is not divided [of the

direction of an object domain in every direction] (330).

[0031] Next, if judge (340) and it is [whether there is any field where only the number of partitions and the division joint location of an one direction in every direction are set up, and] among the appointed field groups, the field where significance is the highest will be set up as an object domain among those fields (350), and it will return to step 310. If there is no field to which only the number of partitions and the division joint location of an one direction in every direction are set among the appointed field groups at step 340, the field where significance is the highest will be set up as an object domain among the non-divided appointed field groups (360), and it will return to step 310.

[0032] Drawing 5 is a flow chart which shows junction mesh division processing. The field where significance is the highest is set up as an object domain among introduction and the appointed field group (step 400), and it judges whether mesh division of all the appointed field groups was carried out (410), and if mesh division of all the appointed field groups is carried out, it will end.

[0033] If mesh division of all the appointed field groups is not completed at step 410, junction mesh division of the object domain is carried out (420), the field where significance is the highest is set up as an object domain among the non-divided appointed field groups (430), and it returns to step 410.

[0034] Drawing 6 is a detailed flow chart which shows the processing which carries out junction mesh division of the object domain of step 420 of drawing 5. Based on the number of partitions and the division joint location of introduction, division conditions, significance, and an adjoining field, the number of partitions and the division joint location of each side of an object domain are determined (step 500). Next, the subregion where the object domain was divided by the number of partitions which determined the subdirection (510), and the principal direction main division side was divided is set up as object subregion (520).

[0035] A subdirection and principal direction main division side is explained to a detail later.

[0036] Next, it judges whether mesh division of the part field was all carried out (530), and if mesh division of the part field is all carried out, it will end. If mesh division of a part field all is not completed at step 530, junction mesh division of the object subregion is carried out (540), the subregion whose next door of object subregion is not divided is set up as object subregion (550), and it returns to step 530.

[0037] Drawing 7 is equality, a junction, and a detailed flow chart that shows the compound mesh division processing which performs unequal mesh division one by one. Introduction and the field group which performs equal mesh division are set up as an appointed field group (step 600), and equal mesh division of the appointed field group is carried out using the processing explained by drawing 4 (610).

[0038] Next, the field group which performs junction mesh division is set up as an appointed field group (620), and junction mesh division of the appointed field group is carried out using the processing explained by drawing 5 (630). Next, the field group of all the remainder that perform unequal mesh division is set as the appointed field group (640), and unequal mesh division of the appointed field group is carried out using the processing explained by drawing 4 (650).

[0039] Next, significance distribution, the main-sub direction of a field, and main-sub division are explained using drawing 13 and drawing 14.

[0040] Drawing 13 is drawing showing the example of significance distribution when maximum of significance is set to 1.0 and it sets the minimum value to 0. It is an example for which significance decreases as distance separates significance distribution of this example from the part where significance is the highest.

[0041] Drawing 14 shows one field which consists of the side 1200, the side 1210, the side 1220, and the side 1230, and significance [in / in significance / in / in significance / in / in the significance in the side 1200 / 0.6 and the side 1210 / 0.4 and the side 1220 / 0.5 and the side 1230] shows the example of 0.8.

[0042] A principal direction points out the direction of [with the larger difference of the significance of the opposite sides], and the side 1210 serves as a principal direction from the side 1230. The subdirection points out the direction of [with the smaller difference of the significance of the opposite sides], and the side 1220 serves as the subdirection from the side 1200.

[0043] The main division side points out the side where the significance of the opposite sides is high, in

the case of the side 1230 and the side 1210, the side 1230 becomes the main division side and the side 1210 becomes with a subdivision side. In the case of the side 1200 and the side 1220, the side 1200 becomes the main division side and the side 1220 becomes with a subdivision side.

[0044] Next, the example of an equal mesh division regulation, an unequal mesh division regulation, and a junction mesh division regulation is explained using drawing 12. As shown in (a), when the number of partitions of the opposite side of a field 1100 is equal, an equal mesh division regulation is a regulation which determines a division joint location and carries out mesh division, as each side is divided into equal die length by the number of partitions, and serves as the division configuration 1110 after division.

[0045] It is the regulation which determines a division joint location and carries out mesh division so that a mesh may become large at **** the side low from the side high [of significance] when the number of partitions of the opposite side of a field 1120 is equal and each side may be divided into die length unequal at the number of partitions, as an unequal mesh division regulation is shown in (b), and becomes the division-after division configuration 1130.

[0046] As shown in (c) and (d), when the numbers of partitions of the opposite side of a field 1140 or a field 1160 differ, a junction mesh division regulation is a regulation which determines a division joint location and carries out mesh division, as a field consists of two or more squares, and serves as the division configuration 1150 and the division configuration 1170 after division.

[0047] Although the mesh division regulation shown here remains for having indicated an example, actually, it can consider many mesh division regulations and is memorized by the storage means 26 as mesh division regulation data 261.

[0048] Next, based on the flow chart of drawing 4, the example of equal mesh division of operation is concretely explained using drawing 8 R> 8. Drawing 8 (a) is beforehand divided into two or more fields, and shows the configuration 700 for analysis where Field a, Field b, Field c, and Field d were specified as an appointed field group. Drawing 8 (b) is the significance distribution map 710 in which P upper left corners of the configuration 700 for analysis showed significance distribution when significance is set up highly with the contour line most.

[0049] First, at step 300, the field a where significance is the highest is set up as an object domain among the appointed field groups. Next, since mesh division of all the appointed field groups has not been carried out (310), it progresses to step 320. At step 320, as an object domain a is shown in the configuration 720 for analysis of drawing 8 (c) based on conditions, such as significance distribution, a mesh size, and an aspect ratio, equal mesh division is performed.

[0050] At step 330, the number of partitions and the division joint location of the same direction are set up to the appointed field group (Field b, Field c) which is not divided [of the direction of an object domain a in every direction]. The figure described into the field b of the configuration 720 for analysis and Field c is the number of partitions of said same direction. Moreover, the division joint location according to the number of partitions is set up on the side of a field, and two points [S], Field a and *****, are division joint locations in Field c.

[0051] Next, by judging whether there is any field to which only the number of partitions and the division joint location of an one direction in every direction are set among the appointed field groups (340), since only the number of partitions and the division joint location of an one direction are set up, as for Field b and Field c, the field c where significance is the highest is set up as an object domain among those fields (350), and it progresses to step 310.

[0052] Since mesh division of all the appointed field groups is not completed at step 310, as an object domain c is shown in the configuration 730 for analysis of drawing 8 (d) based on conditions, such as significance distribution, a mesh size, and an aspect ratio, equal mesh division is performed (320).

[0053] At step 330, the number of partitions and the division joint location of the same direction are set up to the appointed field group (field d) which is not divided [of the direction of an object domain c in every direction].

[0054] Next, by judging whether there is any field to which only the number of partitions and the division joint location of an one direction in every direction are set among the appointed field groups

(340), since only the number of partitions and the division joint location of an one direction are set up, as for Field b and Field d, the field b where significance is the highest is set up as an object domain among those fields (350), and it progresses to step 310.

[0055] Since mesh division of all the appointed field groups is not completed at step 310, as an object domain b is shown in the configuration 740 for analysis of drawing 8 (e) based on conditions, such as significance distribution, a mesh size, and an aspect ratio, equal mesh division is performed (320).

[0056] At step 330, since there is no appointed field group which is not divided [of the direction of an object domain b in every direction], it progresses to step 340. It judges whether there is any field to which only the number of partitions and the division joint location of an one direction in every direction are set among the appointed field groups (340), and since, as for Field d, only the number of partitions and the division joint location of an one direction are set up, Field d is set up as an object domain (350), and progresses to step 310.

[0057] Since mesh division of all the appointed field groups is not completed at step 310, as an object domain d is shown in the configuration 750 for analysis of drawing 8 (f) based on conditions, such as significance distribution, a mesh size, and an aspect ratio, equal mesh division is performed (320).

[0058] At step 330, since there is no appointed field group which is not divided [of the direction of an object domain d in every direction], it progresses to step 340. It judges whether there is any field to which only the number of partitions and the division joint location of an one direction in every direction are set among the appointed field groups (340), is judged with no, and progresses to step 360.

[0059] At step 360, since there is no non-divided appointed field group, an object domain becomes undecided and it progresses to step 310. Since mesh division of all the appointed field groups is carried out at step 310, it is ended.

[0060] Next, based on the flow chart of drawing 4, the example of unequal mesh division of operation is concretely explained using drawing 9 R> 9. Drawing 9 (a) is beforehand divided into two or more fields, and shows the configuration 800 for analysis where Field a, Field b, Field c, and Field d were specified as an appointed field group. Drawing 9 (b) is the significance distribution map 810 in which P upper left corners of the configuration 800 for analysis showed significance distribution when significance is set up highly with the contour line most.

[0061] First, at step 300, the field a where significance is the highest is set up as an object domain among the appointed field groups. Next, since mesh division of all the appointed field groups has not been carried out (310), it progresses to step 320.

[0062] At step 320, as shown in the configuration 820 for analysis of drawing 9 (c), unequal mesh division is performed so that a mesh size may become large from the main division side to a subdivision side about an object domain a at **** by deciding inequality split ratio based on conditions, such as significance distribution, a mesh size, and an aspect ratio.

[0063] At step 330, the number of partitions and the division joint location of the same direction are set up to the appointed field group (Field b, Field c) which is not divided [of the direction of an object domain a in every direction]. The figure described into the field b of 830 and Field c is the number of partitions of said same direction. Moreover, in Field c, five points [S] of Field a and ***** are division joint locations.

[0064] Next, by judging whether there is any field to which only the number of partitions and the division joint location of an one direction in every direction are set among the appointed field groups (340), since only the number of partitions and the division joint location of an one direction are set up, as for Field b and Field c, the field c where significance is the highest is set up as an object domain among those fields (350), and it progresses to step 310.

[0065] Since mesh division of all the appointed field groups is not completed at step 310, as an object domain c is shown in the configuration 830 for analysis of drawing 9 (d) based on conditions, such as significance distribution, a mesh size, and an aspect ratio, unequal mesh division is performed (320).

[0066] At step 330, the number of partitions and the division joint location of the same direction are set up to the appointed field group (field d) which is not divided [of the direction of an object domain c in every direction].

[0067] Next, by judging whether there is any field to which only the number of partitions and the division joint location of an one direction in every direction are set among the appointed field groups (340), since only the number of partitions and the division joint location of an one direction are set up, as for Field b and Field d, the field b where significance is the highest is set up as an object domain among those fields (350), and it progresses to step 310.

[0068] Since mesh division of all the appointed field groups is not completed at step 310, as an object domain b is shown in the configuration 840 for analysis of drawing 9 (e) based on conditions, such as significance distribution, a mesh size, and an aspect ratio, unequal mesh division is performed (320).

[0069] At step 330, since there is no appointed field group which is not divided [of the direction of an object domain b in every direction], it progresses to step 340. It judges whether there is any field to which only the number of partitions and the division joint location of an one direction in every direction are set among the appointed field groups (340), and since, as for Field d, only the number of partitions and the division joint location of an one direction are set up, Field d is set up as an object domain (350), and progresses to step 310.

[0070] Since mesh division of all the appointed field groups is not completed at step 310, as an object domain d is shown in the configuration 850 for analysis of drawing 9 (f) based on conditions, such as significance distribution, a mesh size, and an aspect ratio, equal mesh division is performed (320).

[0071] At step 330, since there is no appointed field group which is not divided [of the direction of an object domain d in every direction], it progresses to step 340. It judges whether there is any field to which only the number of partitions and the division joint location of an one direction in every direction are set among the appointed field groups (340), is judged with no, and progresses to step 360.

[0072] At step 360, since there is no non-divided appointed field group, an object domain becomes undecided and it progresses to step 310. Since mesh division of all the appointed field groups is carried out at step 310, it is ended.

[0073] Next, based on the flow chart of drawing 5 and drawing 6, the example of junction mesh division of operation is concretely explained using drawing 10. Drawing 10 (a) is beforehand divided into two or more fields, and shows the configuration 900 for analysis where Field a and Field b were specified as an appointed field group. Drawing 10 (b) is the significance distribution map 910 in which P upper left corners of the configuration 900 for analysis showed significance distribution when significance is set up highly with the contour line most.

[0074] The configuration 920 for analysis of drawing 10 (c) shows the number of partitions of the side where it is decided except the appointed field group that the number of partitions of the appointed field group and a division joint location will be the mesh configurations of the field by which mesh division has already been carried out.

[0075] First, at step 400, the field a where significance is the highest is set up as an object domain among the appointed field groups. Next, since mesh division of all the appointed field groups has not been carried out (410), it progresses to step 420.

[0076] At step 420, it progresses to step 500 of drawing 6, and as shown in the configuration 930 for analysis of drawing 10 (d), based on the number of partitions and the division joint location of division conditions, significance distribution, and an adjoining field, the number of partitions and the division joint location of each side of an object domain are determined.

[0077] Next, by dividing by the number of partitions which determined the subdirection at step 510, as shown in the configuration 940 for analysis of drawing 10 (e), an object domain a is divided into subregion a1 and subregion a2.

[0078] Since the subregion a1 where the principal direction main division side was divided is set up as object subregion (520) and mesh division of the part field all has not been carried out (530), as shown in the configuration 950 for analysis of drawing 10 (f), junction mesh division is performed for the object subregion a1 using a mesh division regulation (540).

[0079] The subregion a2 whose next door of the object subregion a1 is not divided is set up as object subregion (550), and it progresses to step 530. Since mesh division of a part field all is not completed (530), as shown in the configuration 960 for analysis of drawing 10 (g), mesh division is performed for

the object subregion a2 using a mesh division regulation (540).

[0080] Since object subregion was un-setting up since there was no subregion whose next door of the object subregion a2 is not divided (550), and mesh division of the part field was all carried out (530), it ends and progresses to step 430 of drawing 5.

[0081] At step 430, the field b where significance is the highest is set up as an object domain among the non-divided appointed field groups, and it progresses to step 410. Since mesh division of all the appointed field groups is not ended (410), in order to carry out junction mesh division of the object domain b (420), it progresses to step 500 of drawing 6.

[0082] As shown in the configuration 960 for analysis of drawing 10 (g), as shown in (510) and the configuration 970 for analysis of drawing 10 (h), at step 500, an object domain b is divided into subregion b1 and subregion b2 by dividing by the number of partitions which determined the number of partitions and the division joint location of each side of an object domain based on the number of partitions and the division joint location of division conditions, significance distribution, and an adjoining field, and determined the subdirection.

[0083] Since the subregion b1 where the principal direction main division side was divided is set up as object subregion (520) and mesh division of the part field all has not been carried out (530), as shown in the configuration 980 for analysis of drawing 10 (i), junction mesh division is performed for the object subregion b1 using a mesh division regulation (540).

[0084] The subregion b2 whose next door of the object subregion b1 is not divided is set up as object subregion (550), and it progresses to step 530. Since mesh division of a part field all is not completed (530), as shown in the configuration 990 for analysis of drawing 10 (j), mesh division is performed for the object subregion b2 using a mesh division regulation (540).

[0085] Since object subregion was un-setting up since there was no subregion whose next door of the object subregion b2 is not divided (550), and mesh division of the part field was all carried out (530), it ends and progresses to step 430 of drawing 5. At step 430, since there is no non-divided appointed field, an object domain is un-setting up, and since mesh division of all the appointed field groups was carried out (410), it ends.

[0086] Next, based on the flow chart of drawing 7, it combines using drawing 1111 and the example of mesh division of operation is explained concretely. Drawing 11 (a) shows the configuration 1000 for analysis beforehand divided into two or more Fields a, Fields b, and Fields c. As for drawing 11 (b), 1010 is the significance distribution map 1010 in which Q left part cores of the configuration 1000 for analysis showed significance distribution when significance is set up highly with the contour line most.

[0087] First, at step 600, Field a is set as the appointed field group as a field group which performs equal mesh division, and equal mesh division is carried out using the processing which showed the appointed field a to drawing 4 as shown in the configuration 1020 for analysis of drawing 1111 (c) (610).

[0088] Next, at step 620, Field b is set as the appointed field group as a field group which performs junction mesh division, and junction mesh division is carried out using the processing which showed the appointed field b to drawing 5 and drawing 6 as shown in the configuration 1030 for analysis of drawing 11 (d) (630).

[0089] At step 640, Field c is set as the appointed field group as a field group which performs unequal mesh division, and as shown in the configuration 1040 for analysis of drawing 11 (e), unequal mesh division of the appointed field c is carried out using the processing shown in drawing 4 (650), and it ends.

[0090] Drawing 15 shows the flow chart of the processing which makes the total number of mesh of the appointed field group after mesh division approach the predetermined number of target mesh.

[0091] The conditions from which the number of the appointed field **** mesh serves as min within the limits of introduction and division conditions are set up (step 1300). Next, based on the conditions and significance distribution which were set up, mesh division of the appointed field group is carried out (1310). Next, if the divided number of the appointed field **** mesh is comparable as the number of target mesh (1320), it will end.

[0092] If the number of the appointed field **** mesh is not comparable as the number of target mesh

(1320), it will progress to step 1330. It judges whether there are few appointed field **** mesh than the number of target mesh (1330), in being few, it updates so that the number of the appointed field **** mesh may increase the set-up conditions (1340), and it returns to step 1310.

[0093] If the number of the appointed field **** mesh becomes more than the number of target mesh by the judgment of step 1330, the set-up conditions will be updated so that the number of the appointed field group mesh may decrease (1350), and it will return to step 1310.

[0094] Thus, the total number of mesh of the appointed field group suitable for the analysis precision to need is manageable by carrying out processing made to approach the number of target mesh.

[0095] Although the above example was explained taking the case of division processing of a two-dimensional configuration, it can perform mesh division of a three-dimension solid configuration by transposing a two-dimensional line to a field also in the configuration of a three-dimension solid.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is functional configuration block drawing of the mesh division equipment concerning one example of this invention.

[Drawing 2] It is flow chart drawing of mesh division processing with the mesh division equipment of drawing 1 .

[Drawing 3] It is detailed flow chart drawing of mesh division processing of drawing 2 .

[Drawing 4] It is flow chart drawing showing equal unequal mesh division processing.

[Drawing 5] It is flow chart drawing showing junction mesh division processing.

[Drawing 6] It is detailed flow chart drawing of junction mesh division processing of the object domain of drawing 5 .

[Drawing 7] It is detailed flow chart drawing of combination mesh division processing.

[Drawing 8] It is the concrete explanatory view of the example of equal mesh division of operation.

[Drawing 9] It is the concrete explanatory view of the example of unequal mesh division of operation.

[Drawing 10] It is the concrete explanatory view of the example of junction mesh division of operation.

[Drawing 11] It is the concrete explanatory view of the example of combination mesh division of operation.

[Drawing 12] It is the concrete explanatory view of the example of a mesh division regulation.

[Drawing 13] It is the explanatory view of the example of significance distribution.

[Drawing 14] It is the explanatory view of the main-sub direction.

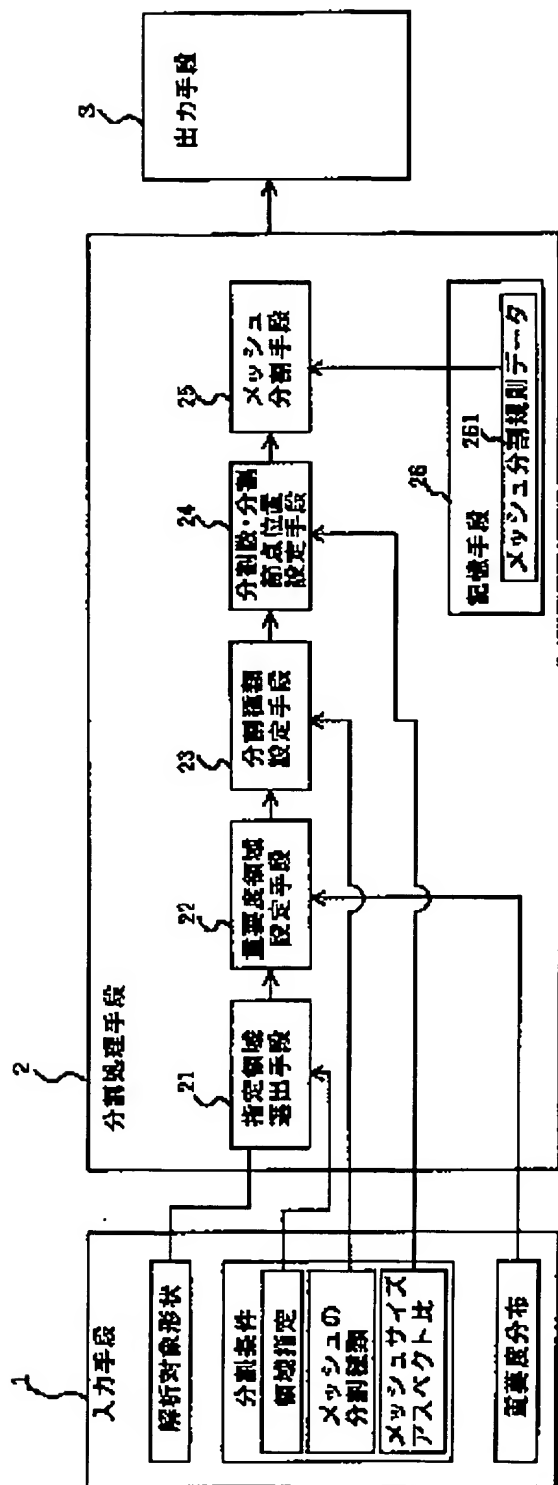
[Drawing 15] It is flow chart drawing of the processing which makes the total number of mesh of the appointed field group after mesh division approach the predetermined number of target mesh.

[Description of Notations]

1 [-- The appointed field election means 22 / -- A significance field setting-out means, 23 / -- A division class setting-out means, 24 / -- The number of partitions and a division joint positioning means, 25 / -- A mesh division means, 26 / -- A storage means, 261 / -- Mesh division regulation data] -- An input means, 2 -- A division processing means, 3 -- An output means, 21

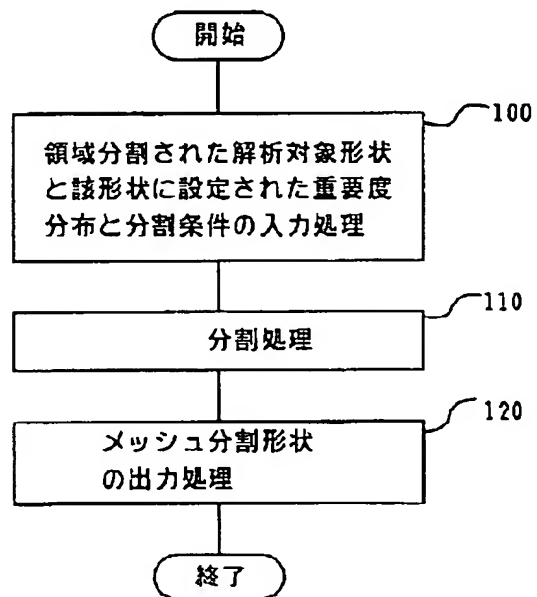
[Translation done.]

図 1



Drawing selection

図 2 ,



[Translation done.]

図 3

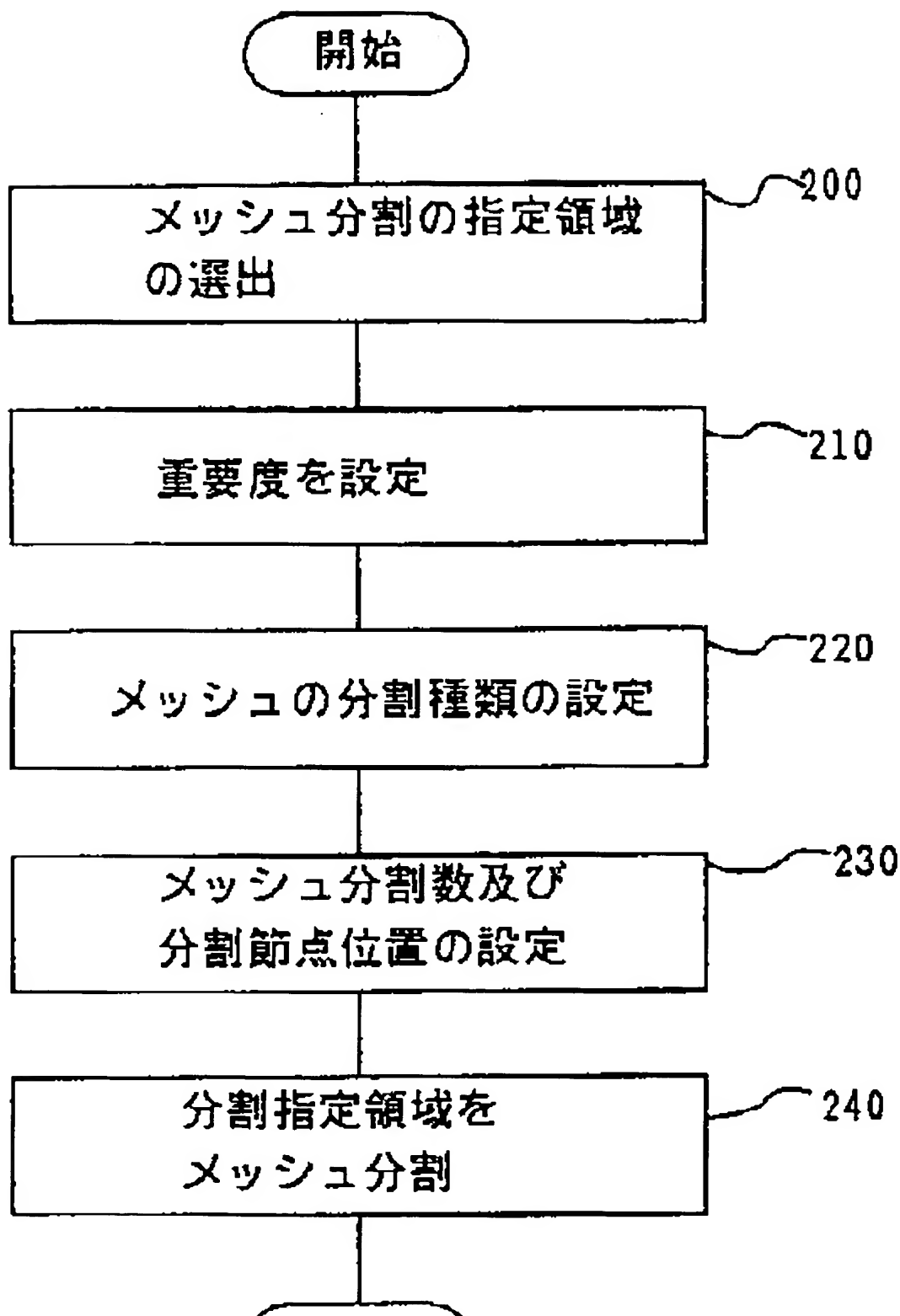
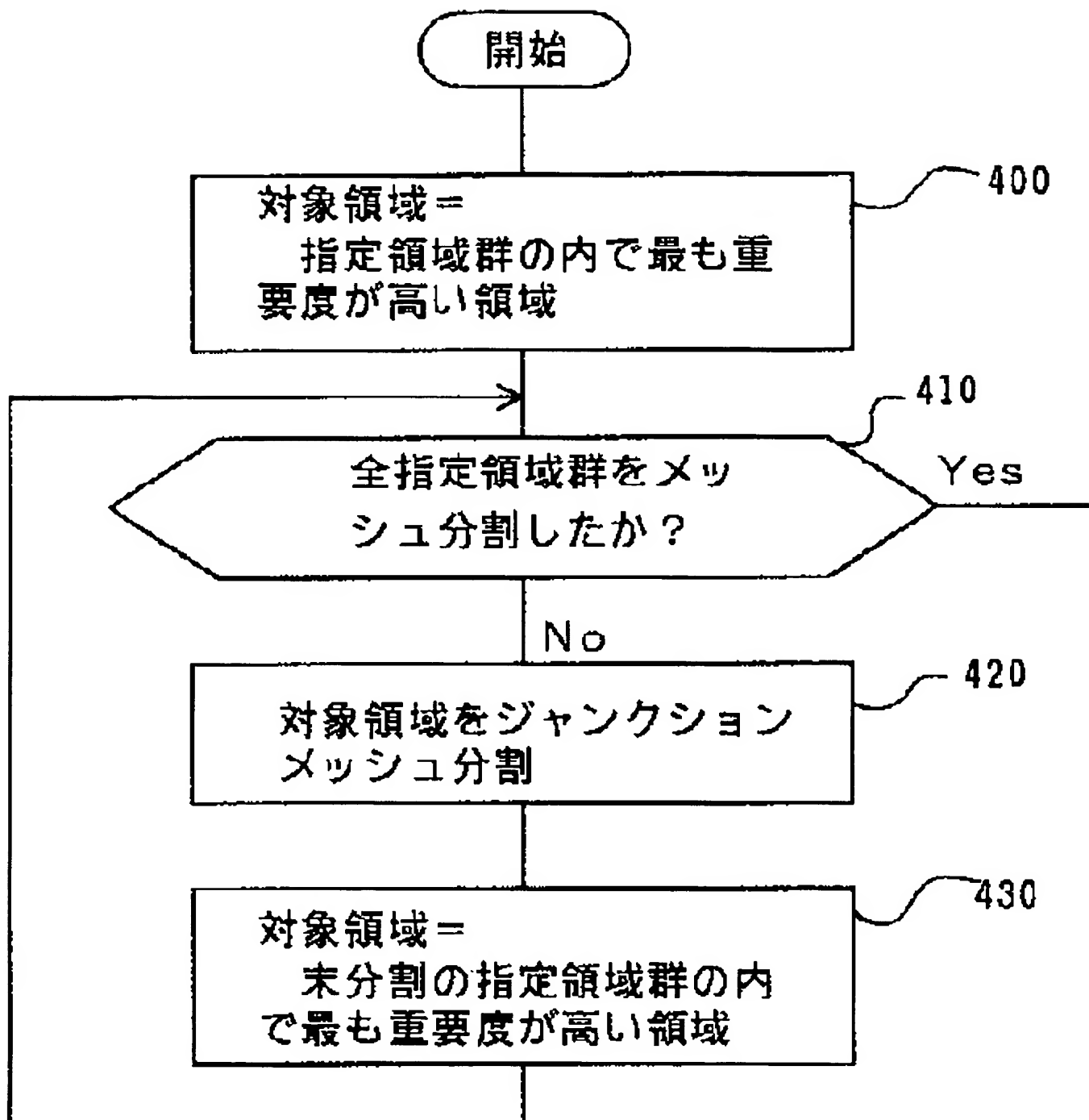
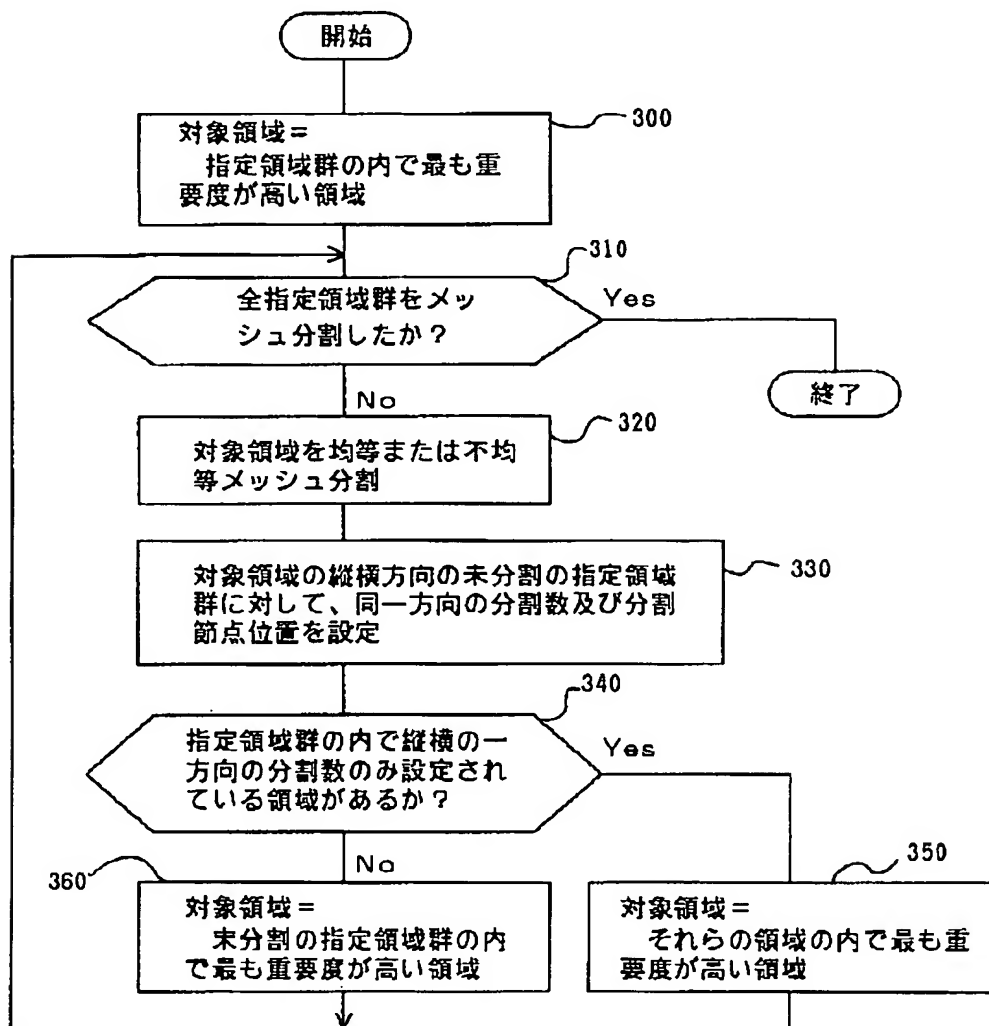


図 5



Drawing selection drawing 4

図 4



[Translation done.]

図 6

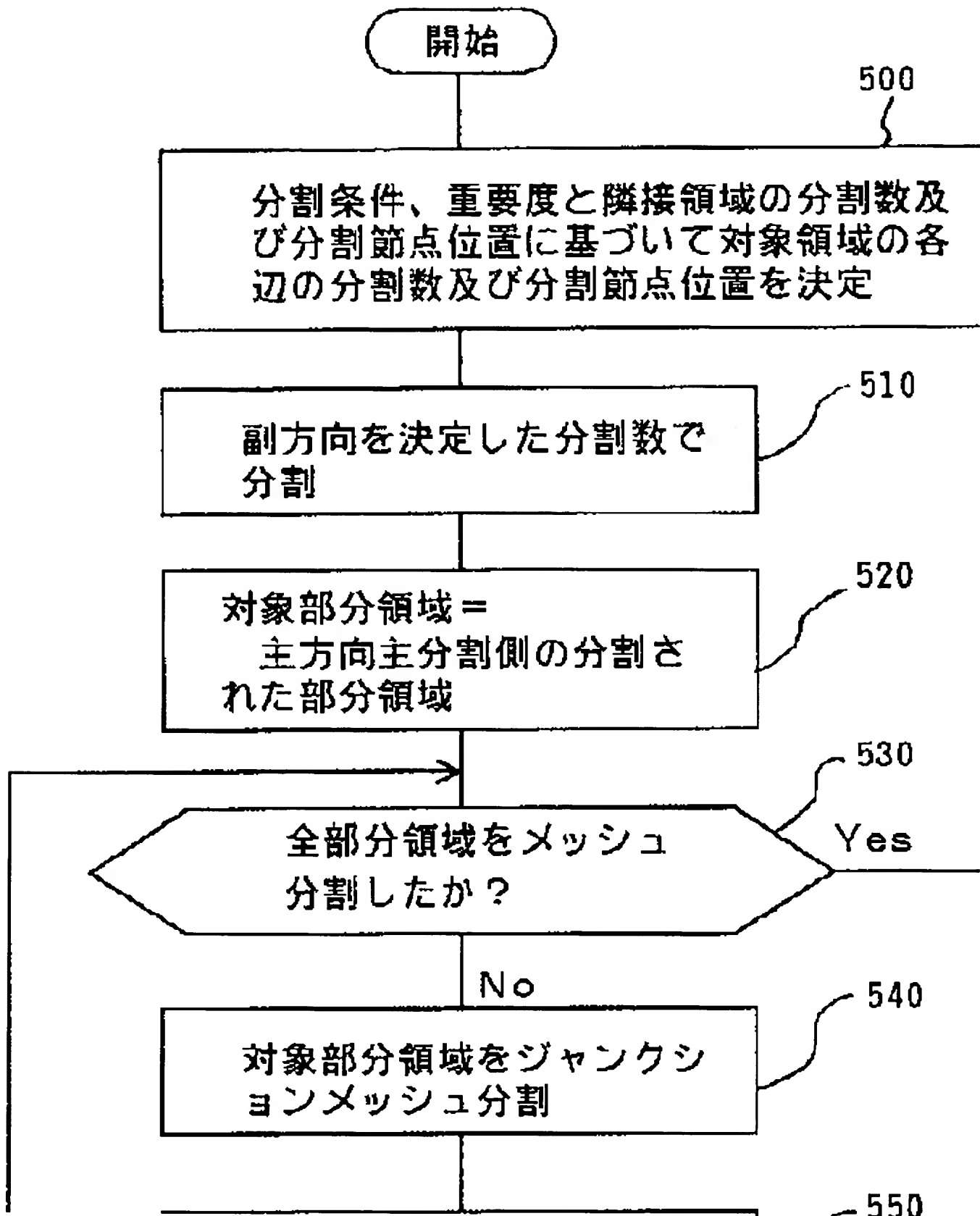


図 7

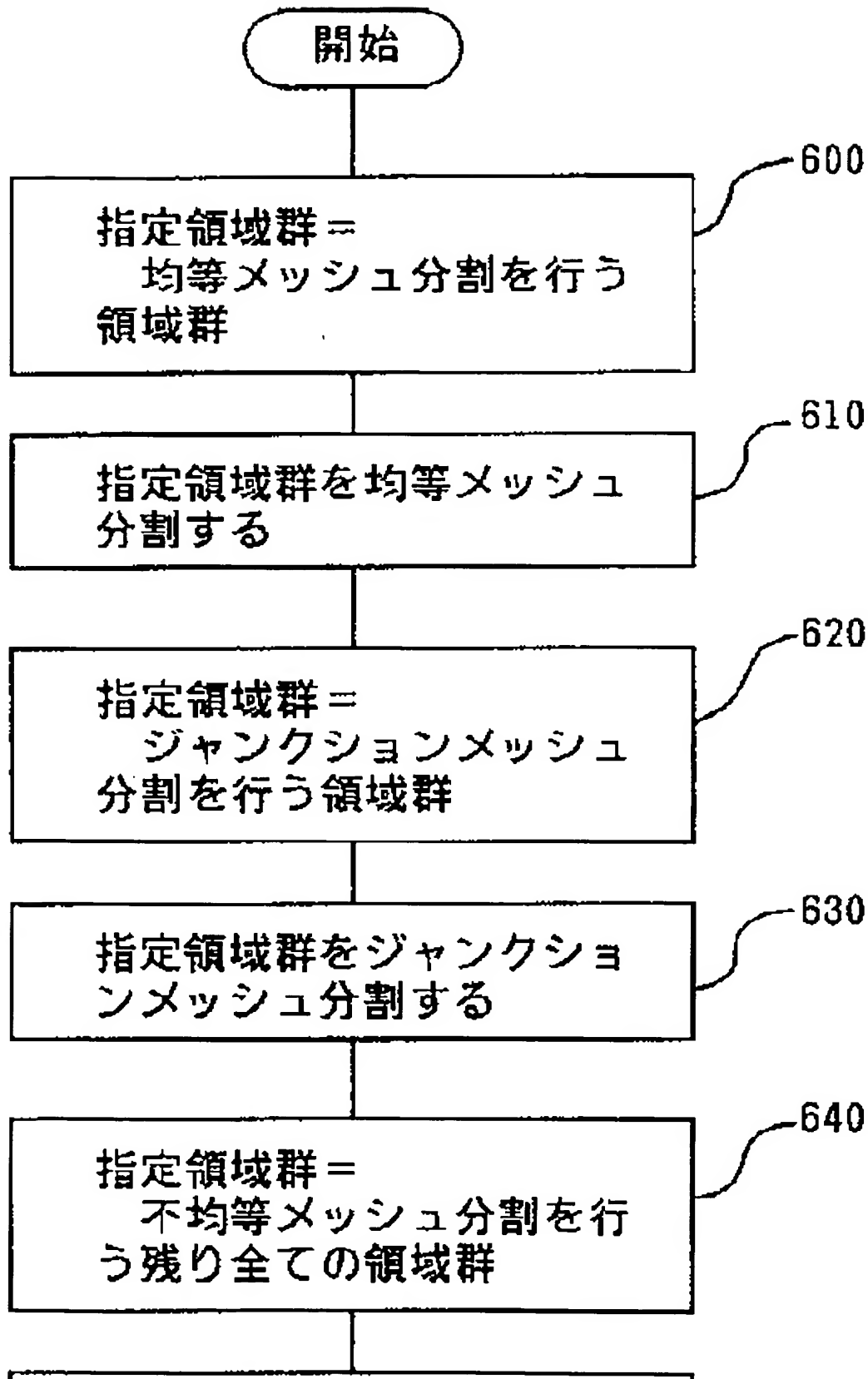
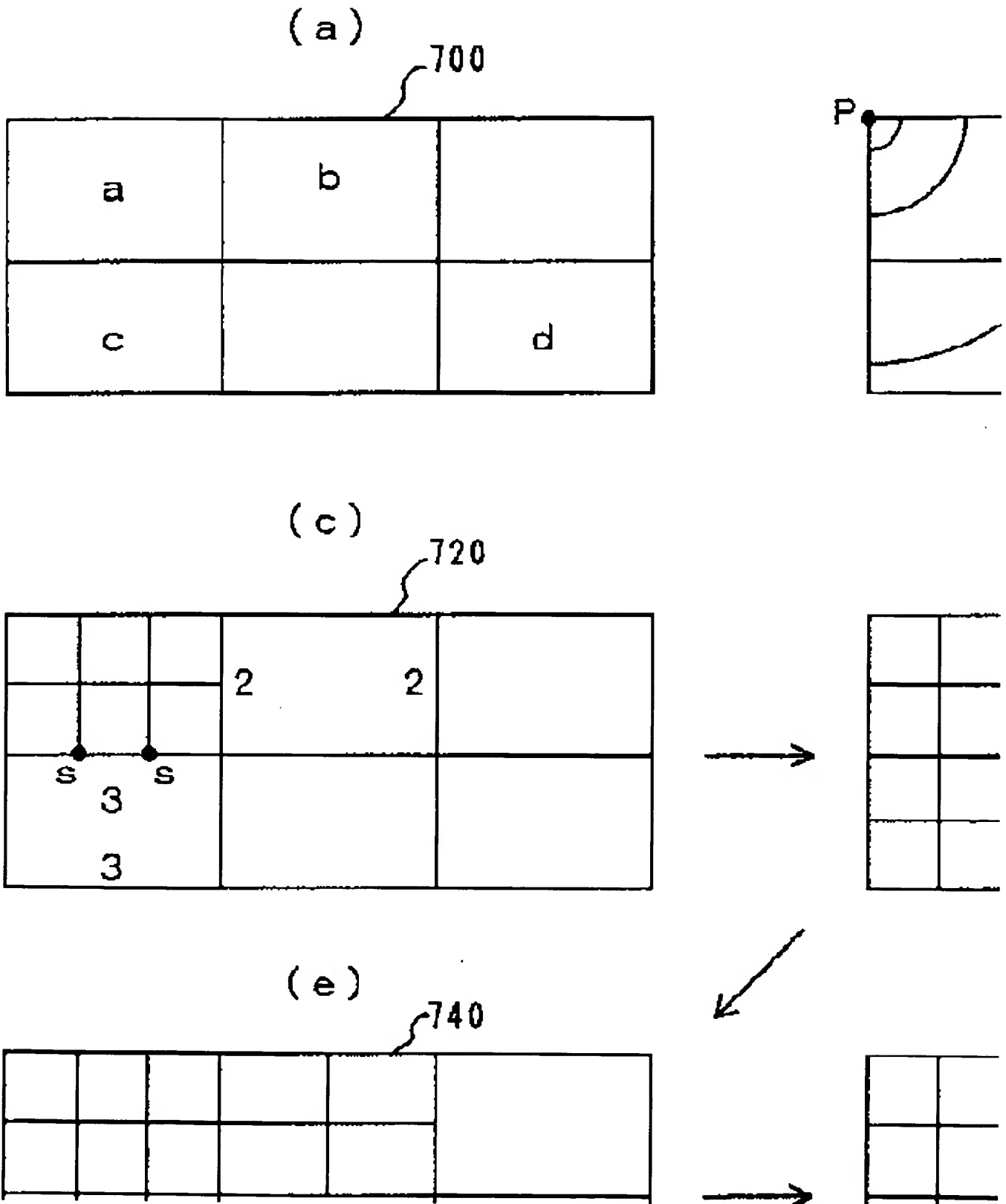
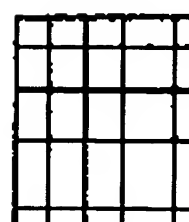
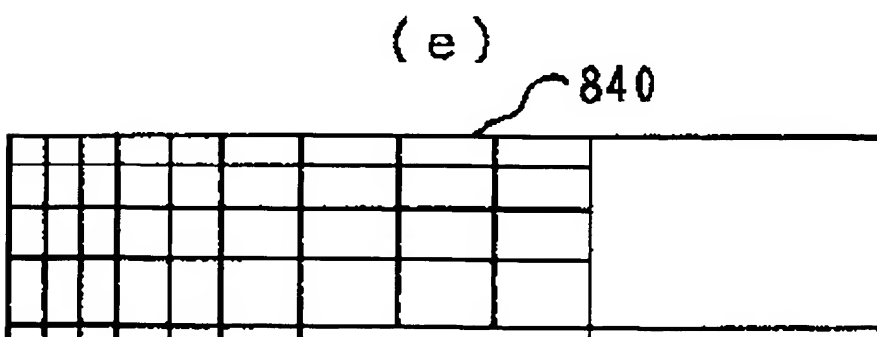
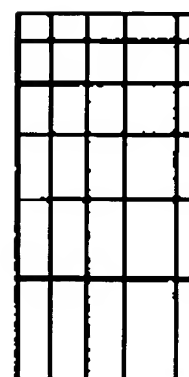
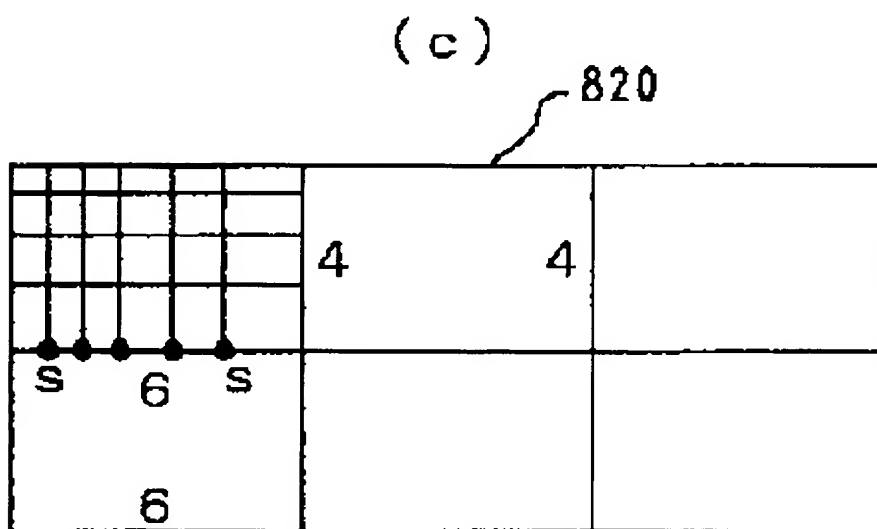
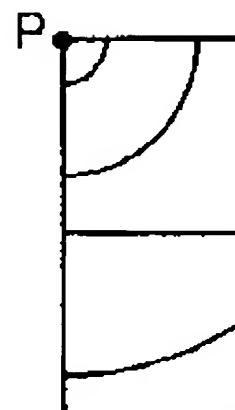
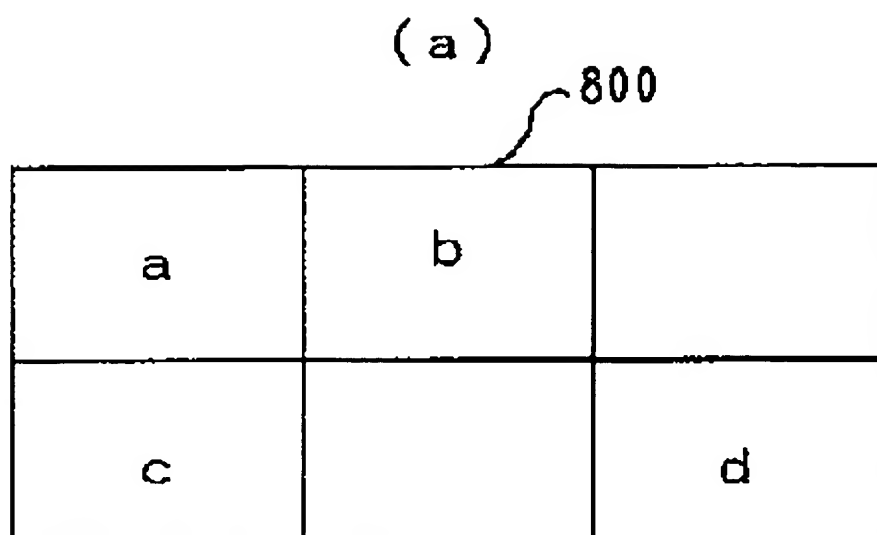


図 8



9



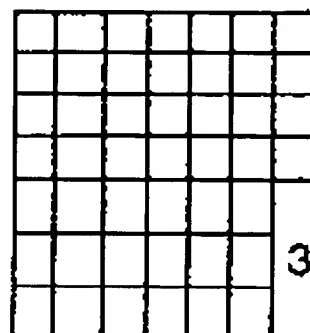
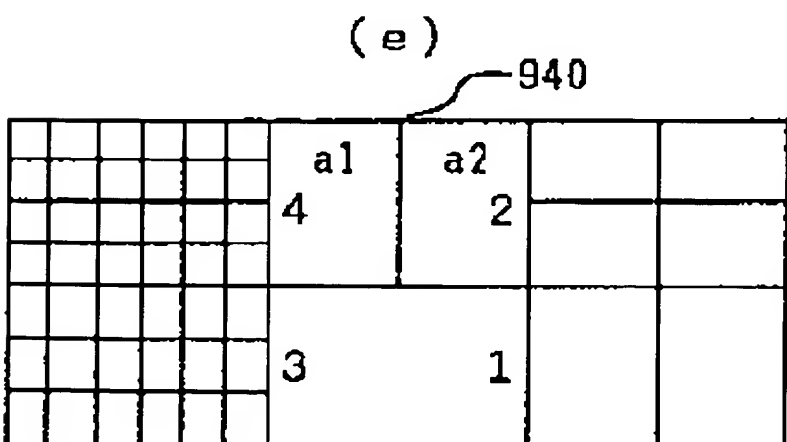
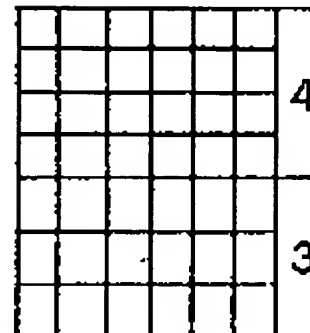
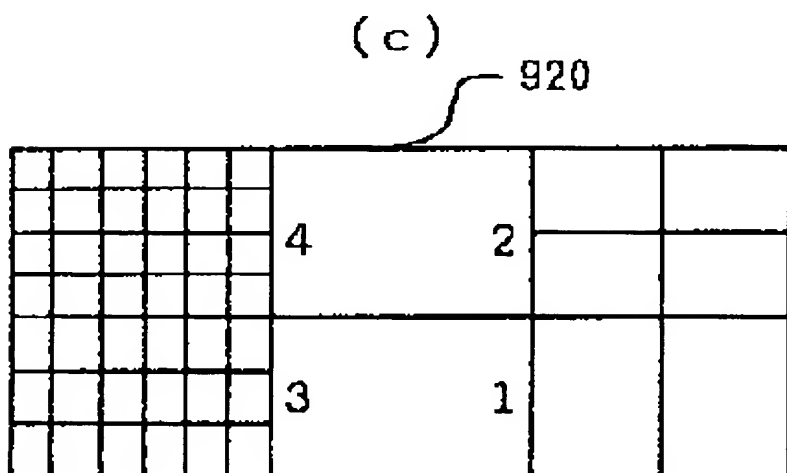
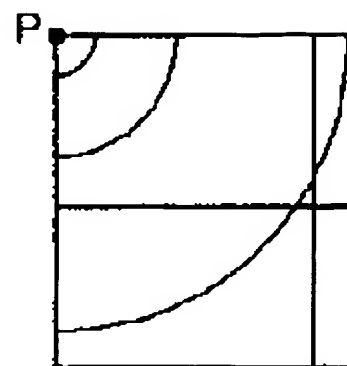
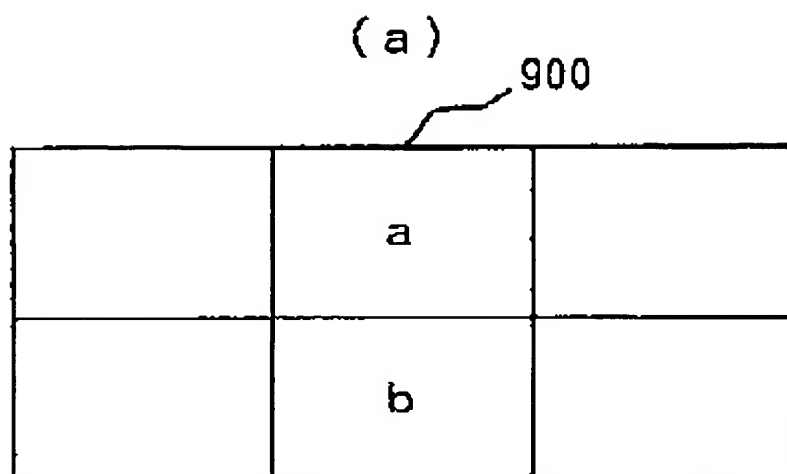


図 11

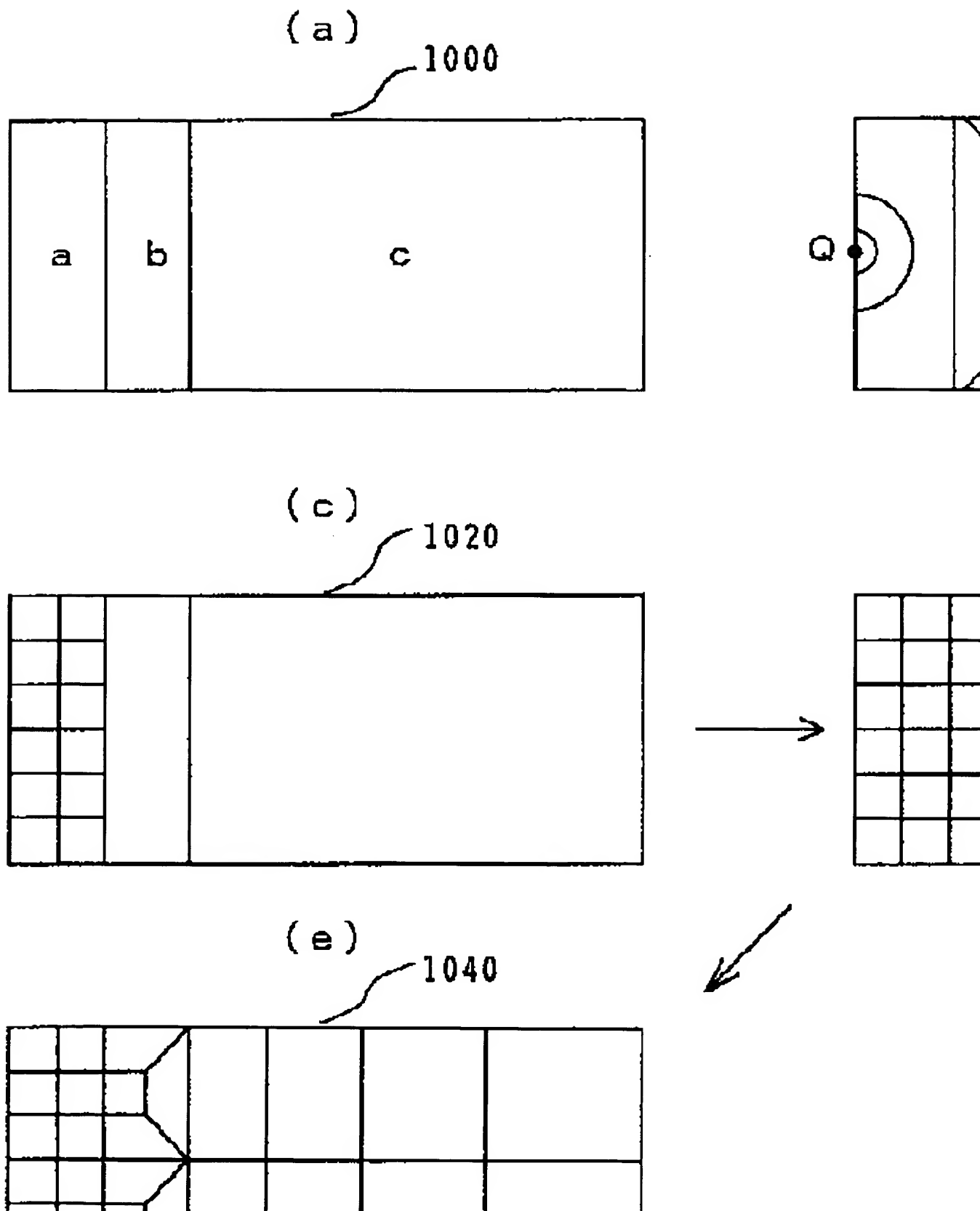


図 14

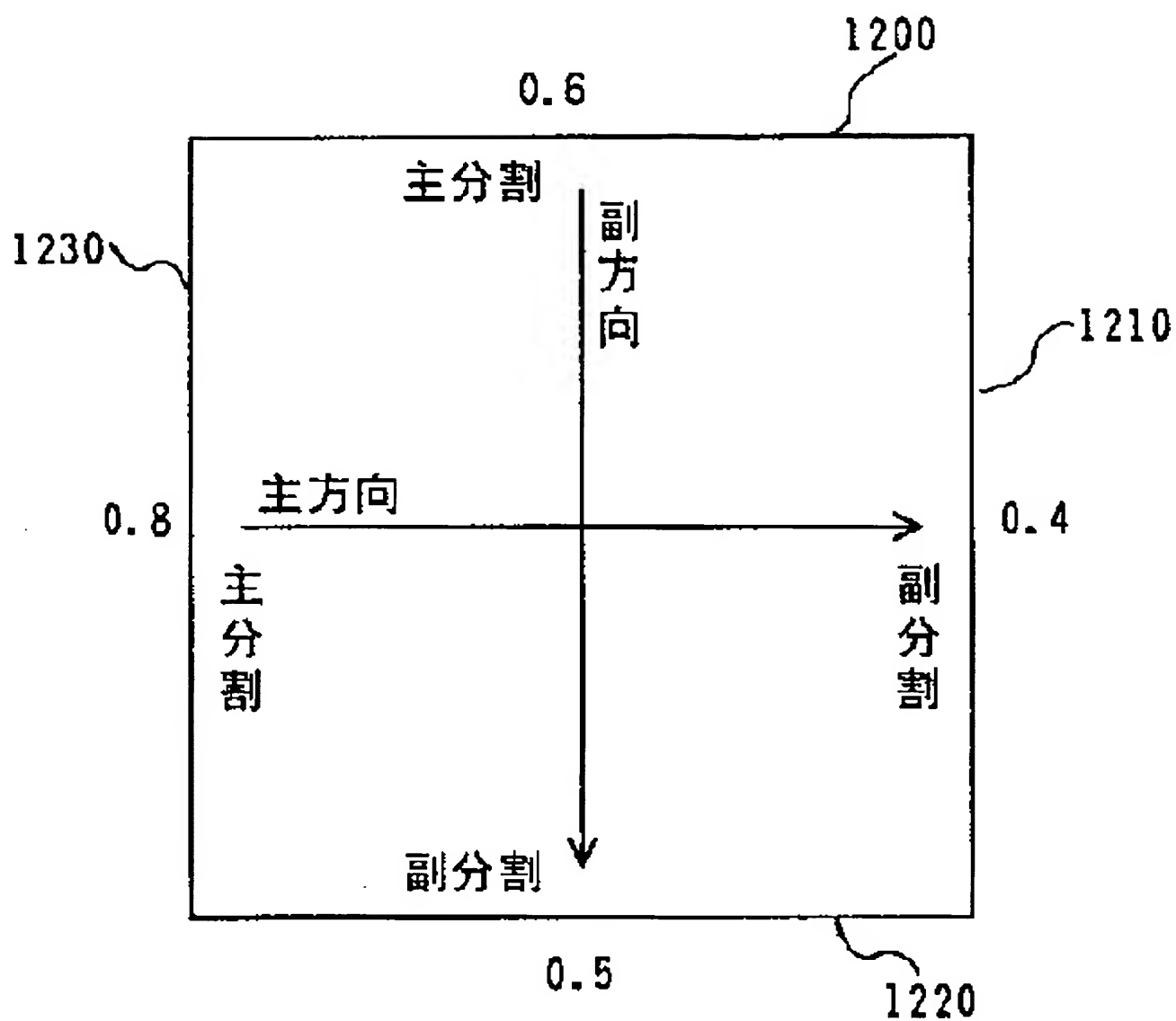


図 12

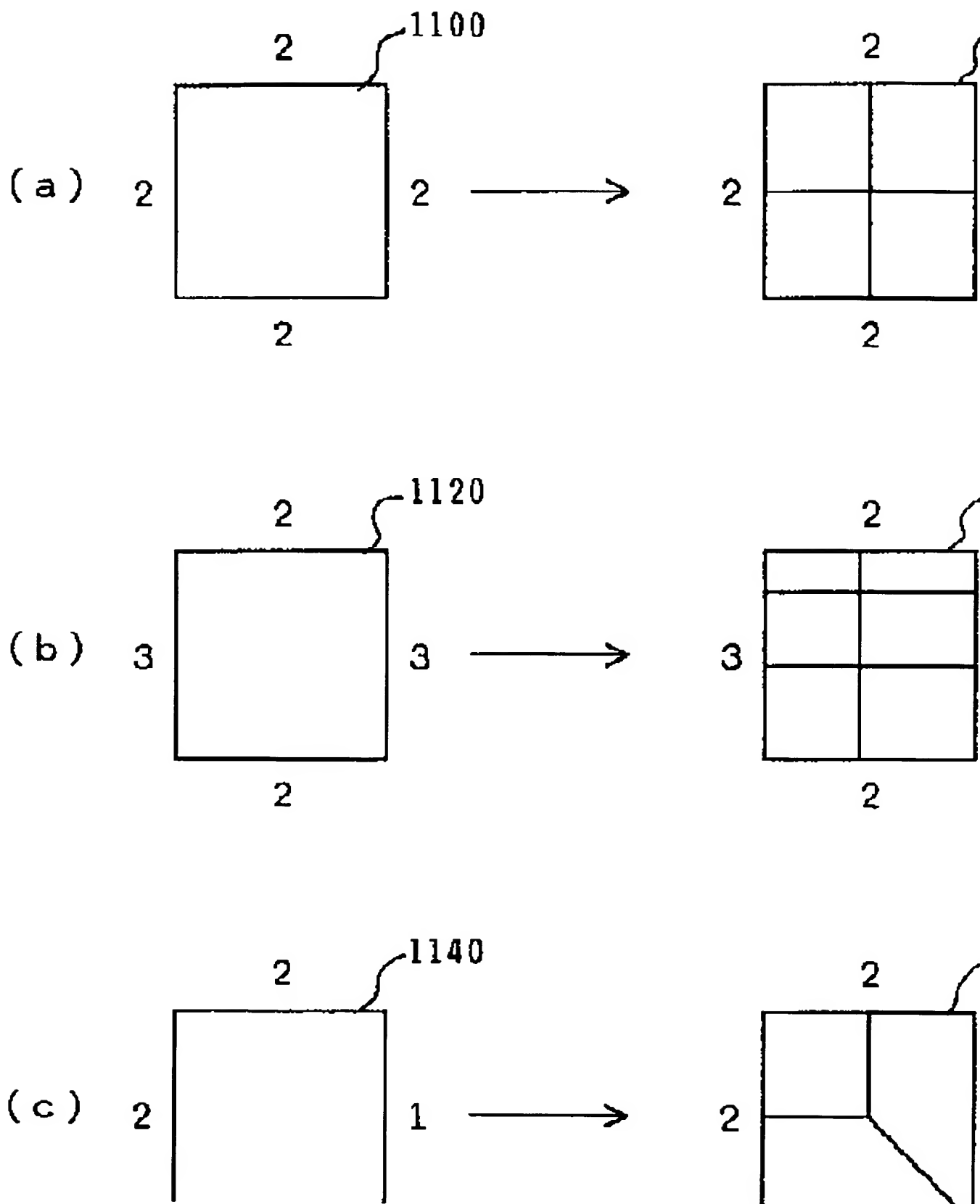


図 11

